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AEROSPACE MANAGEMENT

FOR TECHNICAL DECISION-MAKING AND LONG-RANGE PLANNING

SPECIAL REPORT—Marksmanship In Management . . . . P 47-62

QRC . . . Why You Need It—How To Get It . . . . . P 45

CHARLES W. PERELLE
President, American Bosch Arma Corp.

"... management shows the way" ... P 26

Out where "hard over" won't help a bit...

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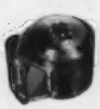

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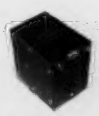

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Circle 4 on Inquiry Card

AEROSPACE MANAGEMENT

FOR TECHNICAL DECISION-MAKING AND LONG-RANGE PLANNING

September, 1961 Volume 4, Number 9

26 **Cutting the Cost of Reliability**

Reliability and cost improvement programs enjoy simultaneous success at Arma; Pres. C. W. Perelle tells how it is done while turning out complex guidance systems.

34 **Lockheed Smashes Bottleneck in Test Data Reduction**

Analyzing test data took five weeks in Polaris development; "Task-force" approach has cut this time to 10 days.

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Highly-touted Navy management system is not without critics at Lockheed; Managers who use it tell where it works and where it doesn't.

45 **Quick Reaction Capability**

The Martin Co. has set up a "super shop" for fast electronics deliveries; Single piece of paper work takes hardware from manufacturing to delivery.

SPECIAL MANAGEMENT REPORT: **Proposals, Procurement Practices, and Profit**

49 ◎ **Profits—Why DOD Pays Them**

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52 ◎ **Procurement Planning in the Navy**

Four basic factors motivate Navy's procurement planning; Deputy Chief of BuWeps discusses them and how they come into play.

54 ◎ **Air Force Centralizes Management**

Systems Command has design-production-procurement authority; Here are the decision areas of each division in this powerful, new command.

56 ◎ **What and How Signal Corps Buys**

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60 ◎ **Proposal—Making Them Pay Off**

Too much top talent is wasted in making proposals that have no chance of payoff; Lockheed advanced-planner tells how management can better use its brainpower.

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COMING NEXT MONTH

SECOND ANNUAL FORECAST ISSUE—The progress of the aerospace industries over the coming years will hinge largely on how effectively funds restricted by economic sanity are managed. Management must establish realistic goals. The future of the aerospace industries will be projected in this Second Annual Forecast Issue.

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Establishing realistic targets is the role of top management. Hitting these targets is a task that falls to the men in middle management who must make proposals, work out designs, and live within the procurement and contracting parameters set by the customer.

Only those who are true "marksmen" will hit their performance, profit, and cost targets.

This 14-page report covers the vital subject of procurement planning in the Air Force, Navy, and Army Signal Corps. It gives a plan for effective use of dollars and brain power in submitting technical proposals. And finally, it tells why DOD will be paying more profits to some suppliers, less to others, in fiscal '62. Heeding the thoughts of DOD on this latter subject will help you increase your profits in the year of the record $46.65 billion budget.

IN NOVEMBER — LOOK FOR

THE SEARCH FOR NEW MATERIALS—From electronics, to structures, to propellants, the massive research program in materials is beginning to pay off. But the big rush is still to come.

IN THE NOVEMBER ISSUE: Managing A Materials Research Program; The Battle For Markets, Metals vs. Plastics vs. Glass; Are Transistors Already Obsolete?

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Accepted as controlled circulation publication at Philadelphia, Pa.

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Published monthly. Subscription rates: U. S., $10.00 per year. Canada, $15.00 per year. Single copies $1.00, special issues $2.00. Foreign $20.00 per year —single copies $2.00, special issues $3.00 per copy.

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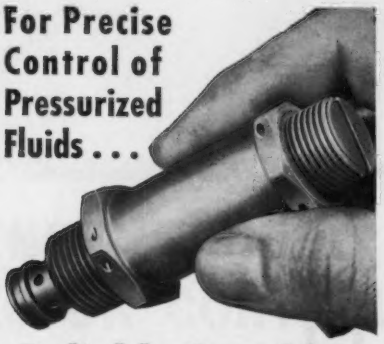
All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

For Precise Control of Pressurized Fluids . . .



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- Eliminates connectors, fittings and lines.
- Reduces leakage points.
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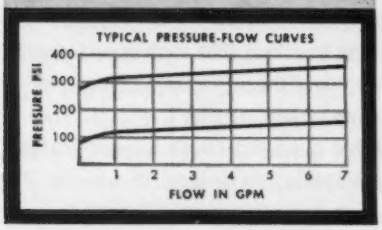
• Simplified circuitry, reduced weight and greater design freedom are other advantages offered by this direct acting relief valve. Used in a multi-stage manifold, this valve can be removed without disconnecting any lines. It is just one of many fluid flow and pressure control valves Fluid Regulators has designed and manufactured to meet exacting specifications.



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- Operating Pressure: Three ranges 75 - 500 psi
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Your Datebook

Sept. 10-12
National Aeronautics Association's
1961 National Convention
Westbury, Long Island
New York

Sept. 11-15
Instrument Society of America
16th Annual Instrument-Automation
Conference and Exhibit
Biltmore Hotel
Los Angeles, California

Sept. 14-15
Technical-Scientific Communications
Conference
Institute of Radio Engineers
Bellevue-Stratford Hotel
Philadelphia, Penna.

Sept. 20-24
Air Force Association
15th Anniversary Convention
Convention Hall
Philadelphia, Penna.

Sept. 25-28
National Fall Meeting
American Welding Society
Hotel Adolphus
Dallas, Texas

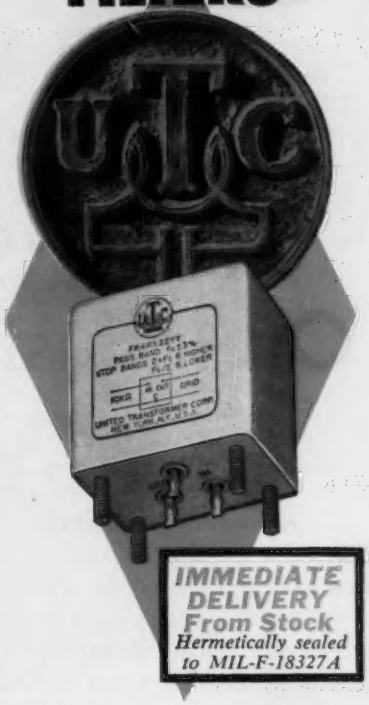
October 2-4
Communications Symposium
Institute of Radio Engineers
Hotel Utica
Utica, New York

October 3-6
Human Engineering Institute
9th Annual Conference
Stamford, Conn.

October 8-14
American Rocket Society
Space Flight Report to the Nation
New York Coliseum
New York, N. Y.

October 9-11
National Electronics Conference
and Exhibition
International Amphitheatre
Chicago, Ill.

STANDARD LINE & INTERSTAGE FILTERS



UTC STANDARDIZED FILTERS have been developed to cover the more common mid-range frequency filter requirements with stock units. All are in compact drawn hermetically sealed cases shielded to reduce hum pick-up. They are divided into seven basic types.

BMI filters are band pass interstage units designed to operate between a vacuum tube plate (or 10,000 ohms) and a grid. They provide a gain of 2 at center frequency.
BTI units are same as BMI, but 10,000 ohms output for transistor application.
BML band pass filters, similarly, work into a grid, but have an input impedance of 500/600 ohms. They provide a gain of 9.
HMI filters are high pass interstage units.
LMI filters are low pass interstage units.
HML filters are high pass with input and output impedance of 500/600 ohms.
LML filters are low pass filters with input and output impedance of 500/600 ohms.

BMI, BTI, BML, HMI, and HML special filters can be obtained for any frequency from 60 to 12,000 cycles. LMI specials are available from 140 to 12,000 cycles. LML filters are available from 500 to 12,000 cycles.

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WRITE FOR LATEST CATALOG

Circle 6 on Inquiry Card

EDITORIAL

Government Nibbles On Industry's Right To Manage

Are we really going back to the arsenal concept in military procurement? We certainly seem to be headed in that Civil War direction.

More and more, rules and regulations on procurement practice are forcing industry into a corner. Government wants more efficient management of aerospace programs, yet it puts a box around management. Each year the industry must operate within a tighter framework.

The mountain of paperwork grows more burdensome and costly to industry and government alike. Industry, however, must show a profit. What is government supposed to show?

Then, of course, there is the constant pressure by the Congress to force economic and social reforms on industry through the excuse of procurement regulations.

After the last round of congressional inquiries, and the scope of new regulations under consideration, we won't have to go much further before the entire aerospace industry is completely nationalized.

For some time now industry has been forced to turn over its drawings to the government with each order. This is one form of nationalization. At this stage of the game, even the General Accounting Office is trying to run the defense program. Because industry has given drawings to DOD, GAO feels that maximum use should be made of these to foster competition through advertised bids. It, GAO, doesn't even consider the advancing technology of today. It believes that anyone can make anything as long as the blue print is available. We doubt that GAO would be willing to admit that such penny-pinching procedures could mean the loss of equipment or worse the loss of life. It can.

GAO has criticized DOD for not making use of "available data" (drawings) to squeeze the profit out of industry.

Congress, knowing the taxpayer likes to hear about saving money, jumped on DOD. Is this the way to operate a government that is supposed to provide for the common defense?

Will these government leaders take us down the path to a nationalized defense industry? They could and might.

Tom MacNew
Editor

STEERING GEAR FOR OUTER SPACE:

BENDIX THRUST VECTOR CONTROL SYSTEMS

SECONDARY INJECTION: Newest way to "call the turns" in outer space. Bendix is now heavily engaged in research and development work on systems to steer Polaris and other missiles and spacecraft. This work involves the study and mechanization of means for deflecting the rocket motor jet by means of liquid and gas injection.

MOVABLE NOZZLES: Proved Bendix system, embodied in the Minuteman program. Responding to signals from the vehicle's "message center," nozzles move to change direction of the thrust, and course, of the rocket. Test firings have proved this system's reliability, time after time. The Bendix system saves 40% in weight compared with previous test systems, and has low actuation torque requirements.

Qualified contractors are invited to write for further information. Write: Bendix Products Division—Aviation, South Bend 20, Indiana.

Bendix PRODUCTS DIVISION South Bend, IND.

Bendix CORPORATION

The stockholders of Chance Vought Corporation and Ling-Temco Electronics, Inc., on June 30, 1961, approved plans for combining these two companies into a vast new company — Ling-Temco-Vought, Inc., effective August 31, 1961.

Combination of these dynamic, experienced organizations links depth of capabilities with depth of management to meet the advanced challenges of electronics, space, communications, aircraft, and missiles.

Ling-Temco-Vought employs more than 20,000 people in the development and production of: AEROSPACE SYSTEMS... ELECTRONICS... COMMUNICATIONS ...SOUND SYSTEMS... AERO SYSTEMS ...INFORMATION HANDLING SYSTEMS.

This is... Ling-Temco-Vought, Inc....a new industrial leader to serve America's future through science.

from left
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Chairman of the executive committee

Robert McCulloch
Chairman of the Board

Gifford K. Johnson
President

Clyde Skeen
Executive Vice-President

LING-TEMCO-VOUGHT, INC.

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Modification

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Electron Corporation

SOUND SYSTEMS
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Altec Service Company
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Ed Friedrich, Incorporated
Friedrich Refrigerators Incorporated

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Reader's Orbit

Outstanding Improvement

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Technical-Current-Readable

Include me on your subscription list. Not many magazines today offer current, technical topics presented in such a readable manner.

I commend the editors for a job well done (on the first of AEROSPACE MANAGEMENT).

J. A. Fedorochko
Assoc. Section Head
Components & Specifications
General Precision, Inc.

Descriptive Title

. . . Have just reviewed the August issue of AEROSPACE MANAGEMENT and am writing to compliment you on the new title. It is more descriptive of the articles published in it than the former Aircraft & Missiles title.

Donald R. Herzog
Market Research Mgr.
Military Marketing
Texas Instruments, Inc.

Upgrading Excellence

. . . would like to congratulate you on your decision to upgrade the title of your already excellent publication . . . AEROSPACE MANAGEMENT has excellent connotations and should contribute significantly to the success of the magazine.

A. W. Scott
Standard Pressed Steel

Through The Hokus-Pokus

. . . Congratulations on the adoption of the title AEROSPACE MANAGEMENT for your magazine.

A day doesn't go by that I don't make some reference to past editions of Aircraft and Missiles. As you well know, I have been one of your most avid fans, and can truthfully state that your magazine has continued to improve and break through much of the hokus-pokus connected with aerospace.

Lt. Col. E. W. Edmonds, Jr., USAF
Hq. Eighth Air Force (DCRM)
Westover Air Force Base

Reprints

Please forward reprints of the following articles appearing in the first issue of AEROSPACE MANAGEMENT:

(1) You Can Get More Reliable Electronics

(2) Total Management Control

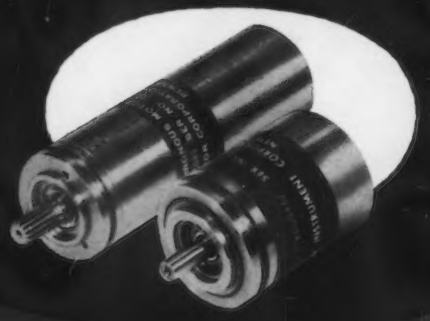
(3) Weapon System Planning and Control

Sincere appreciation is expressed for the excellent services and coverage provided by your magazine and staff.

A. P. Vigliotta
Tech. Director's Staff
Marquardt Corp.

Requests for reprints of articles published in the first issue of AEROSPACE MANAGEMENT have been quite large. Over 200 requests were made in the first two weeks following publication. We are happy to have this kind of response and to offer this service to our readers. We ask that you bear with us if there is a slight delay in filling your request.

new size 8



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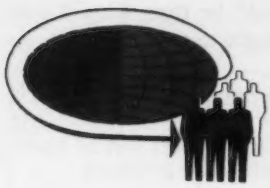
NEW Books

SCIENCE IN SPACE. Edited by Lloyd V. Berkner and Hugh Odishaw. McGraw-Hill Book Co., (330 West 42nd St., New York 36, N. Y.), 1961. 458 pp., $7.00. Space achievements are analyzed by twenty outstanding authorities from the National Academy of Sciences and outside. The implications of these achievements and the new scientific opportunities offered by space science are reviewed. Major topical areas covered include: nature of space activity; gravity; the Earth; the Moon and planets; fields and particles in space; the stars; the life sciences.

ROCKET DEVELOPMENT — Diary of the space age pioneer Robert H. Goddard. Edited by Esther C. Goddard and G. Edward Pendray. Prentice-Hall, Inc., (Englewood Cliffs, N. J.), 1961. 222 pp., paper-bound edition $2.45. This is a compilation of Goddard's notes on his significant experiments covering the period from 1929 until 1941. Each test record is dated and documented with design details such as configuration of vehicles used, dimensions, materials, performance. The objective of each test prefaces each entry, and later, concluding remarks are included to summarize the experience gained toward future improvements. Sixteen pages of illustrations are included showing close-ups of components, installations, and test vehicles. The pioneering work described here presents an accurate picture of a long-neglected genius recognized only too late as the father of modern rocketry.

REACTIONS BETWEEN COMPLEX NUCLEI—Proceedings of the Second Conference on Reactions, May 2-4, 1960. Gatlinburg, Tennessee. Edited by Alexander Zucker, Frederick T. Howard, and Edith C. Halbert. John Wiley & Sons, (440 Fourth Ave., New York 16, N. Y.), 319 pp., $7.00. Forty theoretical and experimental papers are presented giving: results of research projects, interpretations, and discussions on the relations of these results to present knowledge about atomic nuclei. Topical groups include: transfer reactions; Coulomb excitation; scattering; transuranium, fission and low-energy Li reactions; and compound nucleus reactions.



Project Progress

Missiles and Space Vehicles

APOLLO—Isolation room tests at Martin-Baltimore indicate that a pilot on duty in a space vehicle may begin losing alertness after half an hour. The three men of an Apollo mission will rotate watches, but each will be on duty several hours at a time. During major part of space flight the vehicle will travel a set course. The pilot's job will be to watch for emergency situations.

BLOODHOUND 2 — The Bristol/Ferranti Bloodhound Mark 2, surface-to-air guided missile has been ordered by Sweden and Switzerland. The Swiss order is valued at more than $84-million.

COMSAT—NASA will launch AT&T's experimental comsat. AT&T will reimburse NASA for the costs. The Goddard Center and the Bell Telephone Lab will manage the project. Dr. Robert Seamans, Associate Administrator of NASA, will head a Project Review Committee which will handle problems which cannot be handled at the project manager level.

F-1—Complete rocket engine is undergoing static firing at Edwards AFB. Final tests will achieve rated thrust of 1.5-million lb and a firing time of 2.5 min.

HAWK—Aerojet-General has reduced production cost of Hawk motors by approximately 42 per cent during the last 3 years with value engineering techniques. Over 1 million man hours have been devoted to Hawk motor production in 3 years.

IRIS—A new three-finned version of the Iris solid-propellant sounding rocket will be built by Atlantic Research. The original Iris had four fins. The new configuration will make it possible to launch Iris from a number of new launch sites.

LITTLE JOE—Two additional Little Joe space boosters are to be built by North American Aviation's Space and Information Systems division for NASA. This makes a total of nine Little Joe's built by the division. The previous seven boosters were fired successfully, making a perfect score.

MACE B—Two Mace B missiles can be loaded on a C-124 in less than two hours. The special skid, designed by Martin-Baltimore, to hold the two missiles can be unloaded in 45 min. Previously only one Mace B could be carried by the C-124.

MINUTEMAN—A second stage titanium rocket chamber has undergone successful production and hydrostatic testing. The second stage is believed to be the largest rocket chamber ever fabricated of titanium and successfully hydrotested. It was built by Lycoming under a contract with Aerojet-General. Use of titanium reduces weight by approximately one-third.

MINUTEMAN THIRD STAGE — Hercules Powder received contract for more than 50-million from AFSC Ballistic System Div. for continued R & D and limited test production on the third stage propulsion unit for the Minuteman. Work will be conducted at the Bachus, Utah, plant, supported by other Hercules facilities.

NERVA—A $6.3-million six month study contract has been awarded to Aerojet-General for the first phase development of the Nerva nuclear rocket engine. A subcontract went to Westinghouse for the nuclear work. Nerva is part of the Rover Program, a joint AEC-NASA program for development of a nuclear rocket propulsion system. The program is managed by the AEC-NASA Space Nuclear Propulsion Office, which is headed by Mr. Harold B. Finger.

NOVA — Rocketdyne study indicates that a cluster of F-1 engines developing 12-million lb of thrust could be used to send a three-man team on a round trip to the moon. But it would take 14 such launchings to assemble in Earth orbit a vehicle for a six-man Mars journey. It would take over 100 flights for such an assembly with a Saturn C-2 booster.

POLARIS — A new underwater launching facility for testing the Polaris has been completed at San Clemente Island, test range of the U. S. Naval Ordnance Test Station. The variable depth launch facility will be used in test firing missiles from various ocean depths.

RIFT—NASA has awarded a contract to the Martin Co. to study problems involved in flight testing a nuclear rocket engine in an upper stage of a Saturn

booster. This is Martin's second contract under the reactor in-flight test program (RIFT).

SS-11—The U. S. Army has signed a license agreement with Nord Aviation to manufacture SS-11 anti-tank guided missiles. SS-11 is a wire-guided missile with a solid fuel propellant.

SEGMENTED SOLID BOOSTER—A prototype segmented solid booster has been successfully test fired for 80 sec by United Technology. The 26 ft engine produced 250,000 lb of thrust. By clustering such motors, thrusts as high as 25-million lb can be produced. In all, the three segments tested contained nearly 40 tons of propellant.

STAR—General Electric has completed preliminary design work on STAR (Space Thermionic Auxiliary Reactor). Much of the materials development work is underway. The company believes that a prototype STAR power plant could be tested in 1961 with a launch qualified plant following in 1966. The cost for such a program would be from $25-30 million, excluding the cost of flight testing.

TITAN II—Two types of semi-trailers capable of transporting the fuel and oxidizer for Titan II will be built by Beech Aircraft. The trailers will be transportable in cargo aircraft.

Aircraft and ASW

B-52H—Increased thrust of the B-52H's turbofan engines created different handling characteristics because of rapid movement of fuel toward rear of the tanks. Boeing has built a linear acceleration simulator to study the problem. Techniques developed will be included in B-52 improvement studies and on initial designs for more advanced aircraft.

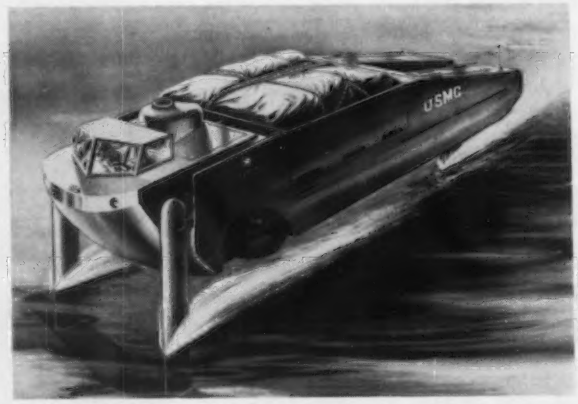
B-58—Shatter proof auxiliary wheel are being fitted to Hustlers as a safe guard against tire failures at takeoff and landing. Aluminum alloy wheels with 15 in. diam are mounted between each pair of B-58 tires. The one in. wide flange drops to the runway if a tire fails.

B-70—First major milestone in building the B-70 was reached recently at Palmdale with the assembly of the lower intermediate fuselage section.

◀ **DOUGLAS A4D-5,** Navy's small versatile attack bomber, recently flew for first time at Edwards AFB.

HUMMINGBIRD, jet VTOL research aircraft, will test jet ejector lift principle. Lockheed is building for Army. ▶

F-105D simulator built by ACF Electronics reproduces responses of aircraft and weapons system. First of seven $1.3-million units has been delivered to TAC.



HYDROFOIL amphibious landing craft will be designed and developed by Avco's Lycoming Div. Craft, with foils submerged will be capable of 45 knots.

B-70—The J93 turbojet engine has undergone 90 hours of testing at Mach 3. Six J93's will power the B-70. General Electric ran the tests which were comparable to the Air Force's preliminary flight rating tests (PFRT).

BOEING 727—Research Designing Service of Michigan will manufacture spars and cords, wing and body stiffeners and floor beams for the new Boeing 727 airliner in a 1¾ million dollar contract. A total of 92 model 727's are on order. First deliveries are scheduled for late 1963.

BOEING HYDROFOIL—A fifty foot 100 knot hydrofoil test craft with twin hulls is to be built by Boeing for the Navy Bureau of Ships. The Hydrofoil is being built as a test bed for the development of high speed supercavitating hydrofoil.

CJ-805-3—The Time Between Overhaul (TBO) for the General Electric turbojets powering Delta Air Lines' Convair 880's has been extended by the FAA from 1200 to 1400 hours. Delta has ordered four more 880's from Convair, which will give Delta 16 880's in service by August 1962.

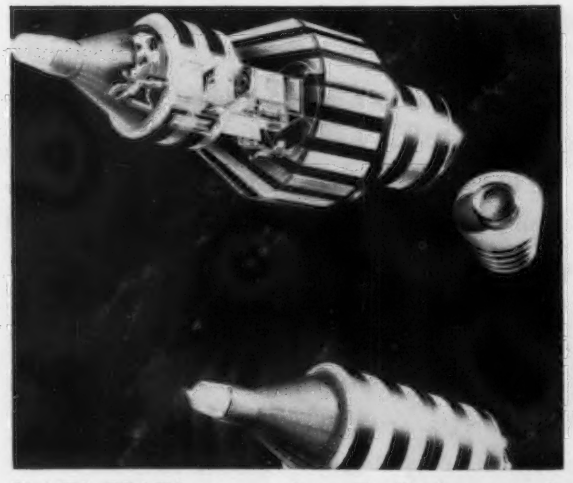
CONVAIR 990—Jet transport has demonstrated during flight tests that it is capable of operating at heavier landing loads than planned in original design. The 990 will be certified for a landing weight of 202,000 lb, an increase of 22,000 lb. Maximum take-off weights were increased on the domestic 990, the 880 and 880-M.

DASH—Recently completed tests at sea have proven the feasibility of the DASH (Drone Anti-Submarine Helicopter) Weapon System. A total of 38 flights were flown, including 22 missions from the U. S. S. Hazelwood utilizing one DSN-1 Drone.

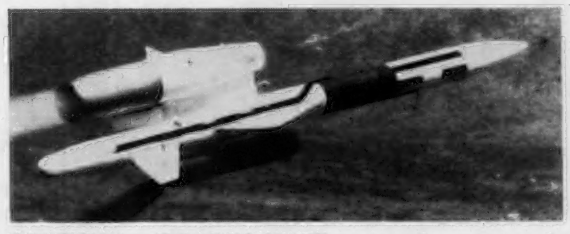
DOUGLAS SST—Douglas is well along on a four year supersonic transport study. Company reports SST is feasible today; could be ready for service by 1970. Douglas design is 200 ft long. Double delta wings stretch 100 ft during subsonic flight. At supersonic cruise at high altitudes the wing tips will droop.

F-105—The largest load ever carried by a single-engine fighter was recently carried aloft by an F-105. More than seven tons of conventional bombs (26 565-lb bombs), mounted on wing and belly racks.

PD 146—Small twin turboprop under development by Beech and three French firms has cruising speed at 15,000 ft of 278 mph. Use of turbines makes possible a cruising speed 53 mph faster than the Beech Baron.



SPACE TRAIN concept from Ford's Aeronutronic Div. features telescoping structures. Structure at top has been expanded to provide lab area. Command center in front could detach and return to earth. Boost configuration at right is preparing to rendezvous. Bottom configuration is going into orbit. Other structures are pressure-stabilized membrane or rigid panel inflatable structures.



REDHEAD ROADRUNNER, Army's supersonic target missile uses ram jet engine built by Marquardt and a disposable solid booster built by North American, who also produces the missile.

SC.9—Nose of British SC.9, a Canberra jet, was converted for Red Top air-to-air guided missile. Red Tops (not shown) have infra-red detectors and proximity fuses that make even a near miss fatal. ▶

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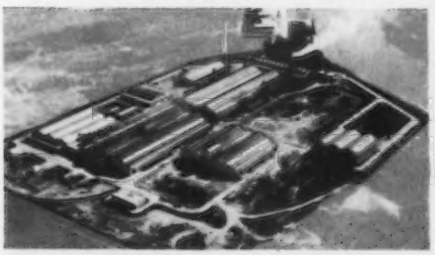

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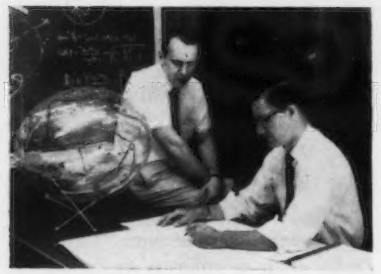
Technical Advances

R & D BRIEFS



Interplanetary navigation system developed at Control Data's Research Div. utilizes an optical system and a miniature digital computer. A special wide-angle camera, mounted in a space vehicle, records the time of appearance and disappearance of various stars and planets through precisely positioned slits in the camera's focal plane. Control Data's researchers, Robert L. Lillestrand (right) and Joseph E. Carroll are shown with a Galaxy Globe which is used to portray position and transit of a manned vehicle in relation to stars and planets on a given space probe.

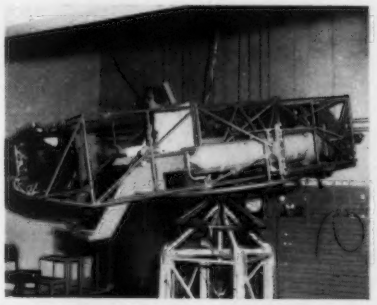
Solid propellant rocket motor was dropped 40 ft onto a steel-covered concrete pad by Rocketdyne. Although the case was dented, the motor was successfully test-fired without malfunction. Purpose of the test was to demonstrate the handling and safety capability of certain solid propellants. Rocket motors are normally required to pass a four ft drop test.

Dynamic compressibility of a solid over a relatively large pressure range can be determined in a single experiment. The new technique, developed by the Navy, uses a rotating-mirror smear camera. Explosive-driven shock waves are observed by the camera. Reflected light, shock luminescence, and the spallation of plastic films are used in the observations.

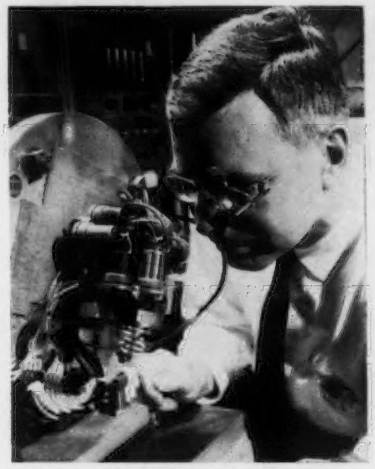
Sun probe, able to send an uninterrupted stream of data from close to the sun's surface could be put into solar orbit in about five years. General Electric's Missile and Space Vehicle Dept. has completed preliminary designs for a 250 lb vehicle able to survive near approaches to the sun. The probe would circle the sun every five months.

EQUIPMENT

Guided parachute, designed by Sandia Corp. for AEC, showed excellent rotational control in full-scale drop tests. Modification will be necessary to achieve a higher horizontal velocity and a smaller lighter control unit. Electromechanically controlled homing parachute will be useful in nose cone recovery and air drop operations.



Automatic controls evaluation simulator can duplicate problems of controlling a vehicle in space. The simulator (ACES) is in operation at the Astronautics Div. of Ling-Temco-Vought. ACES floats on an air bearing. The weight of a coin can cause a reaction.



Integrated accelerometer senses velocity changes from any direction. New device developed by Sperry Gyroscope in key unit in operation of inertial guidance systems. Company claims the component can replace a trio of single-direction accelerometers, the size and weight of which are three times that of the Sperry device.

Exact timing in missile and rocket launch operations will be automatically recorded at the Pacific Missile Range. System electronically marks film and tape records to provide permanent evidence as to the day, hour, minute, second and tenth of a second at which any point of a launch sequence occurred.

Land-Mass Simulator makes possible highly accurate planning of airborne missions involving use of several different types of Navy operational radars. It is an extension of General Precision-Link's film-scanning radar simulators, developed for Navy's A3J weapon system trainer.

Technical Advances continued next page

Cathode ray tube display unit saves time and money because it allows experimentation with different instrument faces without having to make the actual instrument. Unit was designed by Los Angeles Div. of North American Aviation for the Air Force. Device uses an oscilloscope and a circuit connector. Plugging in varying connections creates images of any instruments desired on the oscilloscope.

Dynamic Analyzer reduces the art of vibration and wave form analysis to a simple and practical technique. General Dynamics/Electronics' device is shown being used in wind tunnel flutter-testing of the Convair 990. Center frequency of this inherently frequency-tuned band pass filter is positioned automatically and continuously by an external frequency. Operation does not depend on internal servo control, or frequency-to-DC conversion.

Solar cells made by Hoffman deliver 9.5 to 10 watts sq/ft of surface. Increase from about 8.5 watts attributed to aid of Solar simulator which duplicates sunlight found beyond the atmosphere. Increase in power aids designers in making panels smaller, lighter and more reliable.

MATERIALS

Sweat-cooling of rocket nozzles is now possible with the development of heat-resistant plastic structures that can be made with controlled porosity. Porosity of such nozzle walls can be varied from section to section so that greater cooling could be provided in the nozzle throat than in the divergent section. The porous material developed by Westinghouse's Micarta Div. can be made of glass, leached-glass or quartz fabric with a high temp phenolic resin binder.

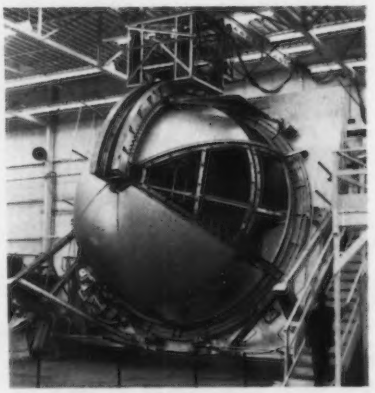
Silicone rubber compounds, under testing by General Electric's Silicone Products Dept., have performed for limited periods of time at temp up to 9000°F. Silicone rubber had previously been considered operational up to 600°F. Materials were tested under the known types of heat energy which would be encountered in space flight and re-entry. Other tests were conducted under high vacuum, corona discharge, radiation exposure and other spatial conditions.

Polycarbutene-R solid propellant, developed by Grand Central Rocket, is claimed to have high combustion efficiency at low chamber pressures. Propellant developed for multi-million pound thrust boosters well suited for upper stage rockets operating in near vacuum of space. Grand Central recently announced completion of first ten foot diam segmented rocket motor chamber.

Solid propellant, developed by Astro-Rocket, can be cast directly into the end-use engine or rocket casing. This process is said to reduce manufacturing cost 25 per cent, as compared with extruded.

PRODUCTION

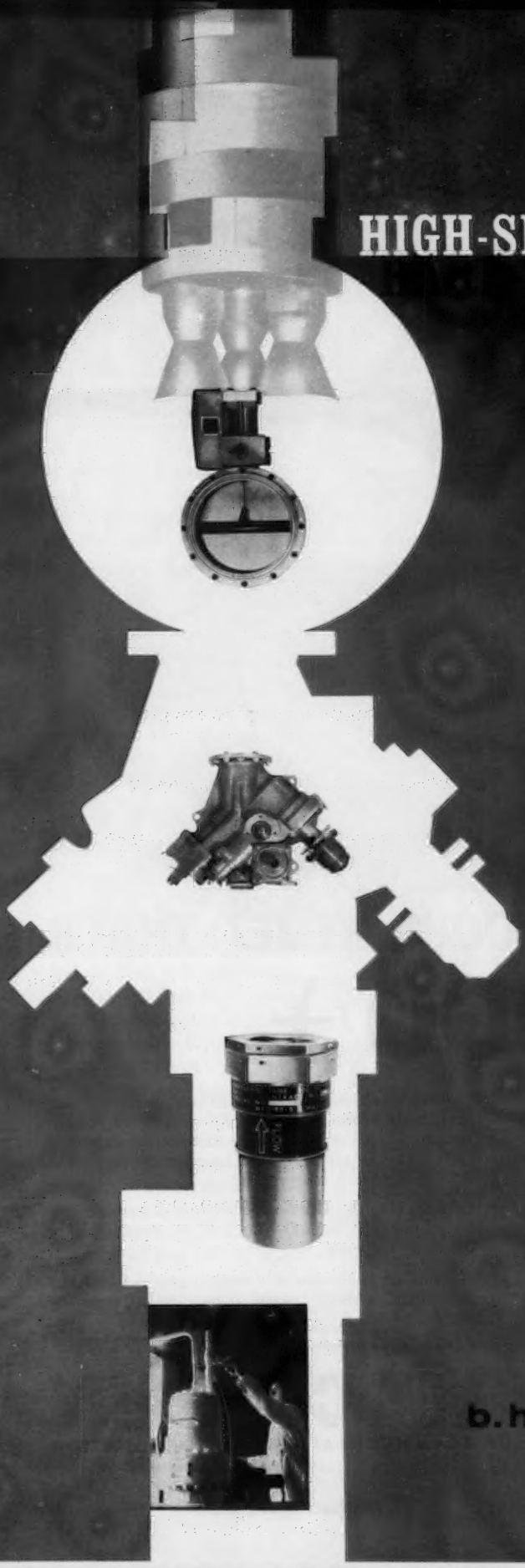
Wiring machine wires 10 times faster than a man is installed at General Electric's Ordnance Dept. to reduce production time of Mark 84 advanced Polaris fire control wiring operations. The new machine automatically feeds, positions, cuts to length, strips and wraps both ends of a wire to terminal posts on a circuit module in less than seven seconds. It takes about two minutes to do the same operation manually.



Welding fixture was designed by Douglas tooling engineers for precision welding of aluminum alloy segments into 18 ft diam dome-shaped bulkheads for the S-IV. Torch at top remains stationary while platform rotates. Photo shows five segments already welded into position. Fixture also includes a milling cutter which trims the base of the bulkhead to size.

Circle 10 on Inquiry Card ⟶

HIGH-SPEC HARDWARE for



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For example, Hadley butterfly valves, available in 3" to 24" diameters, provide optimum flow rates and very low pressure drops over temperature ranges from −423°F to +500°F... handle liquid oxygen, LN_2, Helium Gas, RP-1, JP-4 fuels, UDMH, NTO, LH, ...open and close in 0.1 second... are actuated by pneumatic cylinder, electric motor, pressure cartridge and manual (including servo-positioning). The hermetically sealed 4-inch butterfly valve (left) has a 1 psiΔ P @ 1100 gpm flow.

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Hadley pneumatic and hydraulic check valves, available up to 6" i.d., operate at pressures up to 6,000 psig... at temperatures from −423°F to +450°F... handle Helium, GN_2, Air, Oxygen, RP-1, JP-4 Fuels, liquid oxygen, LN_2. The 1" check valve (left)—part of an ICBM helium pressurization system—has a flow capacity of 30 lb/min at 180 psig inlet... weighs .6 pounds.

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Market Planning

THE $46.6 BILLION BUDGET CRASHING THE BARRIER

Last month, after a series of "raises" that resembled the betting in a wild poker game, fiscal '62 defense appropriations were finalized. The House, Senate, and President, all of whom had taken a turn at increasing the "pot," seemed pleased with the outcome—$46.65 billion.

The "barrier" had officially been broken. Like the sound barrier which so long held a halting hand to aircraft performance, the $40 billion budget had spragged any serious aerospace progress.

In November 1960, this column reported: "when the lid pops off the traditional Eisenhower $40 billion defense budget, spending won't climb, it will soar. The time is not far off." Now, eight months later, the time has arrived. Table 1 shows how the various services fared in the months of shuffling.

Budget Significance—The greatest significance of this new budget is that it has torn loose the shackles of an unrealistic budget ceiling. We are no longer trying to do a large job with a "not-so-large" budget.

Second, there are provisions in the budget that will act as an immediate stimulus to the industry. Of the supplemental increase of $3.4 billion asked for by the President in his July 26 message, $1.753 billion is earmarked for procurement. $1.292 billion of that will be spent in fiscal 1962.

Third, the fiscal 1962 procurement appropriation of $16.675 billion exceeds anticipated expenditures for the first time since the Korean War. Since that time, the backlog of procurement funds has been dwindling. For procurement expenditures to rise, and the market to maintain a high level on firm ground, it is important to maintain a backlog. This budget could start an upward trend.

Fourth, the emphasis on "limited war" capability, or a "balanced force," has broken the curve of decreased aircraft spending which started in fiscal '59. New procurement funds for aircraft are $6.5 billion vs. $6.0 billion last year.

Controversies Resolved—Though most of the budget increases had been anticipated (Who's Buying What In Fiscal '62, Market Planning, July) several important controversies were temporarily resolved by the signing of the appropriations bill.

Though Sec Def McNamara insists he won't spend it, he has $514.5 million for procurement of big bombers, namely B-52 and B-58.

President Eisenhower had asked for only $220 million for the Mach 3 B-70. President Kennedy did not see fit to revise this. The final appropriation bill however gives him $400 million.

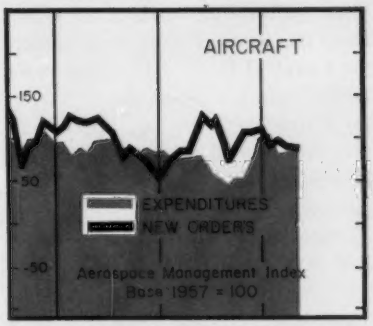
. . . continued on next page

TABLE 1
FISCAL 1962 BUDGET HISTORY
($ Billion)

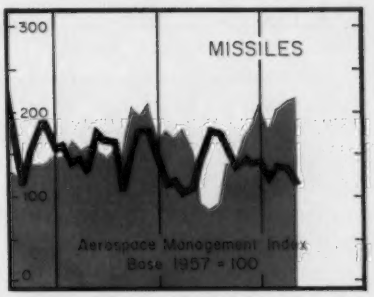
	Eisenhower Request	Kennedy Revise I	House	Kennedy Revise II	Senate	1962 Appropriations
Air Force	17.32	17.72	17.58	18.48	18.93	18.84
Navy	12.04	13.57	13.46	14.62	14.53	14.50
Army	10.17	10.32	10.36	11.76	11.87	11.80
Total Defense Budget	40.84	42.94	42.71	46.39	46.84	46.65

Items do not total because some agencies have been omitted.

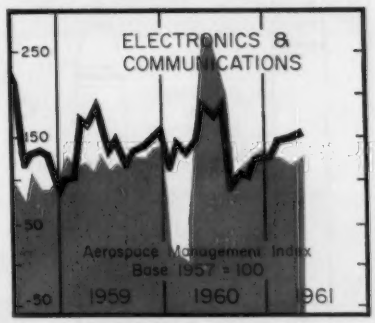
DEFENSE EXPENDITURES AND NEW ORDERS
3 Months' Moving Average Index



Aircraft includes air-frames, engines armament, electronics, and other government furnished equipment. Also included: special tools, test equipment, and ground handling equipment.



Missiles graph includes complete missile systems—armament, launching, guidance, control, boosters, sustainers, propellants, special tools, and ground handling equipment.



Electronics and communications graph is related to the following equipment: radar, electromagnetic equipment, computers, radiation airs, countermeasure, radiac and infrared, meteorological equipment, sonar, transmission or reception units, noise and interference detection devices, test equipment, spares, and related component equipment.

Market Planning

continued

Civil defense was put under DOD with $207 million in funding. General Betts, among others, has argued for this long and hard.

Funds of $19.1 million for utility transports were authorized after Air Force and Navy agreed to resolve their differences. Air Force likes the turbojet Lockheed Jetstar, Navy has favored turboprops, either the Fairchild F-27 or the Grumman Gulfstream.

Dyna-Soar's final 62 appropriation comes to $185.8 million. The Kennedy budget called for $100 million.

Specific Market Effects — Several product markets will enjoy a lift from the increased spending this fiscal year. Among them are:

- Machine Tools
- Materials Handling
- Aerospace Ground Equipment (AGE)
- Electronics
- Components and Spares.

The machine tool modernization program will get new funds. In addition the various aircraft procurements will cause an upswing in tape controlled machines. There are indications that the APT (Automatically Programmed Tools) program can cut production costs. With the increased attention on cost-cutting techniques by top management in industry, the possibility of APT gaining momentum looks good.

New orders for conveying equipment (materials handling) will arise from the ordnance manufacturers and arsenals that will be handling substantial amounts of new munitions.

Big stimulus for the AGE market is the increase from ⅓ to ½ of the Strategic Air Command's bomber wings on 15-minute alert. This will have far-reaching effects.

Over-all electronics and communications funds will be increased by one-third in 1962. This includes such equipment as detection gear for submarines and aerospace vehicles, tactical data processing systems, guidance systems, light weight tactical radios for Army.

The increase in procurement of aircraft and missiles will have resultant impact on component manufacturers. Bearings, hydraulic pumps, gears, small motors, etc., will all benefit.

Spare parts contractors will not only get the benefits that usually come with increased over-all procurement, but will get added effect of having several B-47 wings being continued in service. The spares market could reach $2.2 billion.

Warning Flags

There are some danger signs for contractors who have been doing or seeking maintenance and overhaul work on aircraft and missiles to heed.

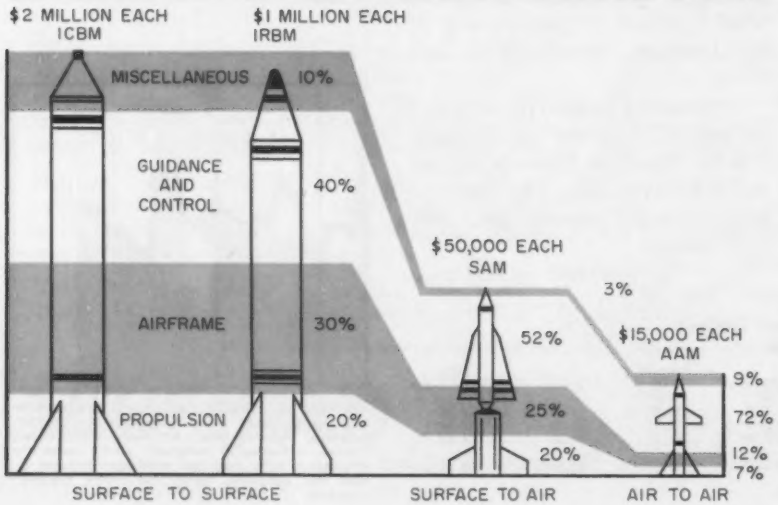
Air Force, which now contracts out 60 per cent of its maintenance, has announced it will pull back at least 20 per cent of this to its "in-house" maintenance facilities.

Army, which contracts out an even greater percentage of aircraft maintenance than Air Force, is aiming for a 40 per cent "in-house" capability.

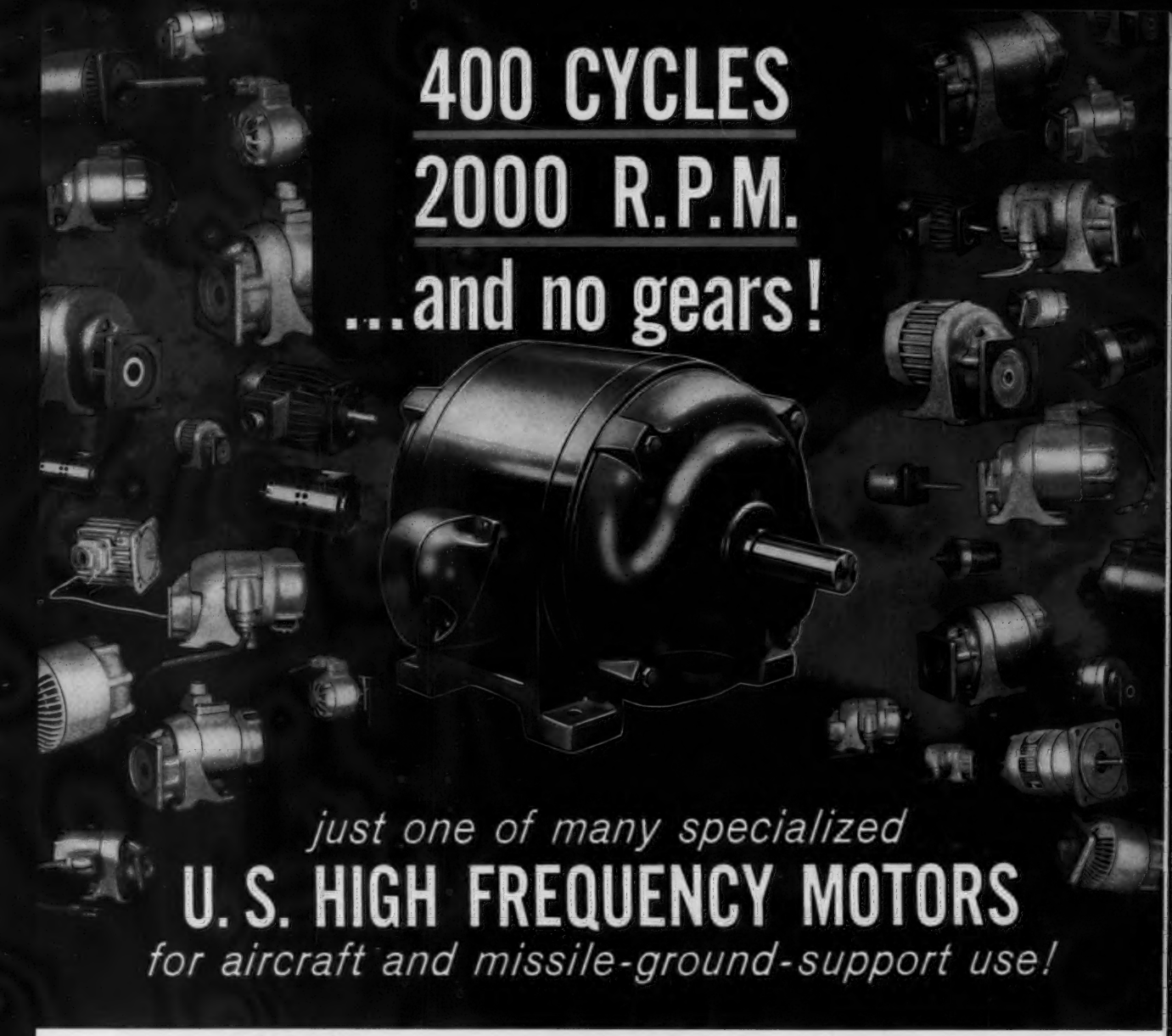
Commercial Satellites

NASA and American Telephone and Telegraph (AT&T) have consummated an agreement which breaks the ice in the civil-communications satellite market. AT&T will design and build communications satellites for two launchings in 1962. NASA will furnish the launch vehicle, launch-facilities, and tracking facilities. AT&T will reimburse NASA for all expenses the government incurs.

Hughes Aircraft and NASA are also negotiating a $4 million contract that calls for three launchings. Target is a non-stationary 22,300 mi orbit. Project is known as Syncom.



RULE OF THUMB cost breakdown of production charges shows markets for electronics (guidance and control), airframe, propulsion, and miscellaneous items in the family of missiles. Chart is based on study conducted by the economics division of Stanford Research Institute.



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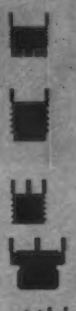

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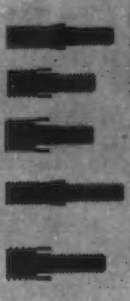

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Business Activity

Air Force Reorganization

Air Force Headquarters Staff has been reorganized. Development, procurement and logistic support of aircraft, missiles, space and electronic systems have been combined into one office. Lt. Gen. Mark E. Bradley heads the new office as Deputy Chief of Staff for Systems and Logistics (DCS/S&L). His office will assume duties previously assigned to DCS/Materiel.

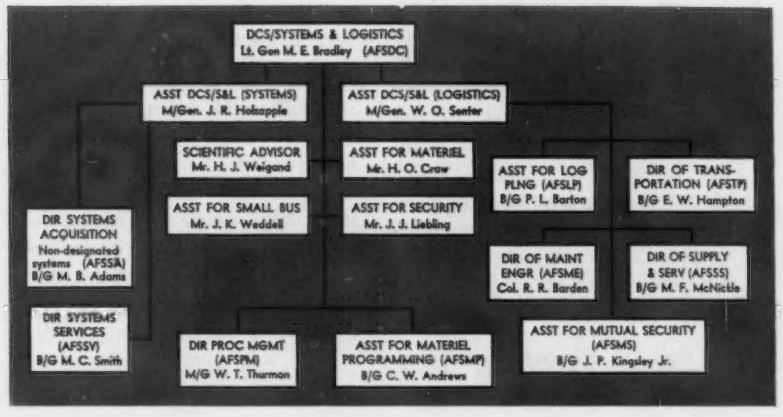
The Director of Systems Acquisition under DCS/S&L, Brig. Gen. Milton B. Adams, will supervise staff functions of development, procurement, production and review of all system programs. Certain systems such as Minuteman and the B-70 bomber will have individual System Staff Officers (SYSTO's). Each SYSTO will report directly to the Assistant Deputy Chief of Staff for Systems. (See chart below.)

Both the Air Force Systems Command and the Air Force Logistics Command are now established as procuring authorities. To provide guidance for this program the DCS/S&L has a Director of Procurement Management. Major Gen. William T. Thurman is responsible for establishing major policies and procedures for the field agencies.

Research, advanced technology, studies requirements and development planning functions have been assigned to one office. Lt. Gen. Roscoe C. Wilson heads this new office as Deputy Chief of Staff, Research and Technology (DCS/R&T). General Wilson's chief assistant is Major Gen. Victor R. Haugen, Assistant DCS/R&T.

Other principal assistants in DCS/R&T are Major Gen. Marvin C. Demler, Director of Advanced Technology; Brig. Gen. Ralph L. Wassell, Director of Research; and Major Gen. William B. Keese, Director of Development Planning.

General Wilson's office will be responsible for long-range planning, policy and objectives for Air Force research. In addition, it will be the military focal point in the Air Force for scientific and technical interaction with other agencies such as AEC and NASA.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M/Gen. J. R. Holzapple
ASST DCS/S&L (LOGISTICS)
M/Gen. W. O. Senter
SCIENTIFIC ADVISOR
Mr. H. J. Weigand
ASST FOR MATERIEL
Mr. H. O. Crow
ASST FOR LOG PLNG (AFSLP)
B/G P. L. Barton
DIR OF TRANSPORTATION (AFSTP)
B/G E. W. Hampton
ASST FOR SMALL BUS
Mr. J. K. Weddell
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Mr. J. J. Liebling
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B/G M. F. McNickle
DIR SYSTEMS SERVICES (AFSSY)
B/G M. C. Smith
DIR PROC MGMT (AFSPM)
M/G W. T. Thurman
ASST FOR MATERIEL PROGRAMMING (AFSMP)
B/G C. W. Andrews
ASST FOR MUTUAL SECURITY (AFSMS)
B/G J. P. Kingsley Jr.

Centralized Marketing

Sperry is integrating defense marketing efforts into a central unit. M. H. Jennings will direct Sperry Central Marketing, handling major weapons systems for land, sea and air, missile systems, guidance and navigation equipment for aircraft, missiles and space craft, telemetry, computers, and radars.

In a similar move, B. F. Goodrich has replaced its Aviation Products division with an Aerospace and Defense Products group. The new division has company-wide responsibility for direct contract sales to DOD and other federal agencies. The company's consolidated sales to the federal government last year amounted to $55,825,740, 7.3 per cent of the total net sales. C. B. McKeown has been appointed general manager of the new division.

Value Programs At Work

Aerojet-General's cost reduction through value engineering has produced savings. Approximately $1-million of U. S. Army funds have been saved in Hawk solid fuel motor production.

General Electric's Missile and Space Vehicle Dept. cut $7,710,000 from operating costs during 1960 with their cost improvement program. This brings savings to $20,-850,000 during the past three years. Sixty per cent of the savings were made in R & D and the remainder in manufacturing and administration. By product, the savings were roughly $4.2-million from nose cone work, $2-million from space satellite work and $1.5-million from all other projects.

. . . Business Activity continued next page

ORGANIZING TO IMPROVE PRODUCTION

Technicians are getting harder to find. This includes gyro technicians.

The Precision Products Dept. of Nortronics, a division of Northrop Corp., made a study of the availability of capable gyro technicians. They found that 80 per cent of the men tested needed either a review or remedial ir.struction in gyro electronics.

Only 8 to 10 per cent of the electronic technicians that apply for a job can qualify in this field. By 1965, the need for these skilled technicians will double.

Nortronics has devised a pre-employment exam to test for specialized ability. It indicates the amount of training needed to supplement an individual's present knowledge to state-of-the-art techniques in building gyros.

After careful study and consultation with Northwestern University, Nortronics launched a company sponsored training program, tailored to the specific needs of its gyro technicians.

This course is designed to provide a broad background of knowledge applicable to their specialization. Course content is split into three phases lasting one and a half years. Classes are conducted on company time. This allows Nortronics to evaluate present abilities and future potential. The technician is able to apply the new or revived knowledge to their everyday functions. Improved skills and a better understanding of engineering and production problems are the result.

The principles involved in this course can be applied to any industry interested in cutting costs through a more efficient production organization.

The Martin Co. has reported first half sales of $408,193,230, a gain of $106-million over the first half of 1960. Statement also listed a profit before taxes of approximately $5,290,000 from the liquidation of the Company's investment in the stock of General Precision Equipment Corp. Net earnings during first half were $1.56 per share.

IBM has formed a Components Div. The new organization is responsible for developing and manufacturing as well as purchasing electronic components, including magnetic cores, diodes and transistors, used in IBM data processing equipment. Dr. John W. Gibson has been named general manager of the division with headquarters in Poughkeepsie, N. Y.

Thiokol Chemical's first half earnings totaled $2,242,755 an increase of 29 per cent over the same 1960 period. Net sales were $84,996,405 for the six-months.

Loral Electronics Corp. has acquired American Beryllium Co. and its subsidiary companies, United States Beryllium Corp. and Visioneering Co. The new acquisition will operate as a wholly owned subsidiary of Loral, with O. F. Quartullo continuing as chief executive.

Douglas Aircraft Co. has reorganized "to enhance its growth in missiles and space and strengthen it for the development and production of future and existing aircraft. Two new integrated, product oriented divisions, one for missiles and space and the other for military and commercial aircraft." Heading the two new divisions are Charles R. Able, v.p. and gen. mgr. for Missiles and Space, and Jackson R. McGowen, v.p. and gen. mgr. for Aircraft.

MANAGEMENT QUOTES

N. E. Halaby, administrator, FAA: "In undertaking a national effort for development of a supersonic transport, we believe certain basic principles should be kept in mind at all times. First and foremost is that the program is one of Government assistance to industry. . . . The program is not intended to be one involving total Government subsidy."

Sen. Clair Engle (D-Cal.) urging that a total of $12-million be spent in 1962 to begin work on a $500-million supersonic transport. He said that private aircraft companies do not have the capital to do the job. "Four of our leading aircraft manufacturers have capital resources varying between slightly less than $200-million to about $275-million."

Dan A. Kimball, president, Aerojet-General, commenting on Aerojet's acquisition of 45 per cent interest in Global Marine Exploration Co.: "The age of discovery of valuable minerals and other resources on the ocean's floor or just beneath the earth's outer crust is just beginning. There is every reason to believe that in the future we will be able to extract from the ocean and ocean's floor products as important to man as those which have been extracted from the land for thousands of years."

William M. Allen, pres., Boeing: "To date, The Boeing Co. has invested $5-million in supersonic transport research and that is but a beginning . . . present estimates place the dollar outlay required to design, construct and flight-test a prototype supersonic transport at approximately $100-million, exclusive of engines."

MAJOR CONTRACTS

Aerojet General—$1.39-million for production of liquid propellant rocket sled system and components. $1.2-million for solid motor test stand instrumentation at Redstone Arsenal.

ARO Inc. — $25,950,000 for management, operation and maintenance of the Arnold Engineering Development Center for the Air Force.

Atlantic Research — $900,000 for production of over 500 Arcas rockets, and $500,000 for new three-finned version of the Iris rocket.

Avco Corp.—$29.6-million for Titan and Atlas re-entry vehicles. $3.08-million for HU-1 and AO-1 Army helicopter engines. $3-million for Lycoming T53 gas turbine development.

Bendix Corp.—$600,000 from Boeing for B-52H production equipment. $739,000 from Navy for 218 VHF airborne communications systems for P3V and P2V aircraft. $2.9-million for Advent shipboard terminals (brings Bendix's Advent contracts total to $23-million). $1,107,090 for ground power generators and regulators for the Air Force.

Boeing Co.—$1.46-million from Navy for design and construction of a 15-ton high speed hydrofoil test craft. $23.1-million definitive contract for C-135A jet transports.

Cessna Aircraft—$5-million for continued production of T-37B for Air Force.

Chrysler Corp. Missile Div.—$1,227,138 for R & D work on Saturn rocket program.

Douglas Aircraft Co.—$3,343,-395 from Air Force for modernization of facilities for use in work on Skybolt.

Garrett Corp.—$3-million from Army for follow-on production of Sergeant gas turbine generator sets at AiResearch Mfg. Div.

General Dynamics — $6.2-million from Army for further Mauler development. $12.95-million for B-58 flight test at Fort Worth. $3.38-million for Atlas work. $1-million to General Atomics Div. for classified research. $1.8-million for Atlas missile trainers. $2.2-million for Atlas tests.

General Electric—$1.2-million for Atlas work. $882,000 for capsule to test fuel cell battery in space for 30 days. $1.89-million for ECM radar. $1.3-million for Little John rocket kits. $21-million for J-79 engine improvements and production. $4-million for jet engine prototypes. $4.1-million for height finding radar modification kits.

General Motors — $3.4-million for Thor guidance and ground equipment maintenance. $2.6-million for repair and other work on Titan guidance. $40-million for bombing and navigation systems.

General Tire & Rubber—$1,045,254 for main landing gear wheels Century series fighter aircraft (F-100, F-101, F-102, etc.) and $1,174,411 for tires for T-33 jet training aircraft.

B. F. Goodrich — $3,661,160 for B-52 tires.

Goodyear Aircraft Corp. — $3,137,530 from Air Force for improving the reliability of Mace.

Paul E. Hardeman & Fishback & Moore—$37.7-million for construction of Titan facilities at Little Rock AFB.

Paul E. Hardeman Co.—$8.9-million from Navy for two Pt. Arguello launching pads with a six-month option for a third pad at $3.5-million. $14.5-million for Titan propellant loading system.

Hercules Powder Co. — $50-million from Air Force for R & D of a third-stage motor for Minuteman.

IBM — $5,574,700 from Air Force to improve bombing and navigation systems for B-52.

Lockheed Aircraft — $53,847,-360 for F-104G spare parts, ground equipment, special test vehicle and conversion of some F-104A aircraft to drones.

Martin—$2.25-million for initial production of Bullpup. $7.78-million for Pershing. $6.1-million for Dyna-Soar booster.

Northrop Corp. — $9,528,639 from Army for Hawk launchers, Sergeant warhead components and flight service for RP-76 target missile.

Pan American World Airways—$87.7-million for Atlantic Missile Range operation and maintenance.

RCA — $3,827,282 from Air Force for ECM receiving set components and $13,897,675 for radio receiver sets.

Raytheon Co. — $4.9-million from Army for Hawk radar and radar test equipment.

Ryan Aeronautical—$1,687,128 for Q-2C target drone work.

Reflectone Electronics—$11.8-million for ECM simulators for Air Force jet bomber crew training.

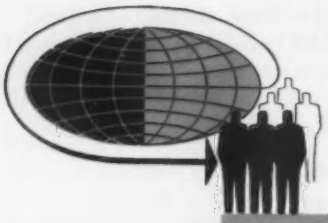
Sanders Associates — $40-million for electronic weapon systems for aircraft, ASW and missile defense.

United Aircraft—$1.38-million includes contracts from FAA for computer programs, from Air Force for continued R & D on an ion engine and basic research on an ion beam. $2.44-million for R & D on light weight airborne gas generator.

Vitro Corp.—$7.45-million from Air Force for management, maintenance and operation of the Eglin Gulf Test Range.

Sperry Rand—$29.9-million for Sergeant missile systems, test and ground equipment.

Thiokol Chemical — $2-million add-on for Sergeant, Pershing, and Nike Hercules motor production.



THE VIEW FROM TOP MANAGEMENT

Cutting The Cost Of Reliability

- *Cost control and reliability programs have paid off in Atlas guidance.*

  Here are the results:

  (1) Inertial unit has not been the cause of a single Atlas failure.

  (2) About $1 million has been shaved from overall costs in first half of this year. Target is $2.5 million.

- *Vast responsibility and authority of Product Reliability Dept. is major factor in success.*

- *Such plans can work only if . . .*

. . . management shows the way

by Charles W. Perelle, President
American Bosch Arma Corp.

Improving reliability without increasing cost is standard operating procedure with our company. American Bosch Arma lives by the favorable cost-benefit ratio as prescribed by Secretary of Defense McNamara (AM, Aug., 61).

We also believe in a line and staff type organization with the necessary authority and responsibility spelled out for management people.

Management programs on reliability and cost control were initiated some time ago at American Bosch Arma. The benefits have been outstanding.

The Arma Div. has had notable success with the Atlas guidance-system reliability. That same Division has saved almost $1 million in the first six months of this year with our corporate "cost improvement program." Coupling these items with proper bids on proposals and vendor selection analysis has made our entire defense management organization efficient in overall cost-savings.

Education in Reliability — We have an extensive program at Arma to impress every single employee with importance of reliability in the Atlas.

This education program is being run in two phases. Both are carried out continuously and simultaneously. The first is one of publicity, the second is one of basic education.

The publicity phase is aimed at keeping certain ideas in every employee's mind. We want to make sure he is receptive to the education in reliability he will get from the second phase. The ideas are simple ones: (a) Reliability Is Important (b) Your Job Is Important In The Overall Reliability (c) Reliability Comes With Difficulty, etc. We use posters, decals, articles in the house organ, and letters to the employee at his home to get these ideas across.

The educational phase is implemented through more direct and specific contact. Twice each month, a supervisor calls all his men to-

The inertial guidance package for which American Bosch Arma Corp. has prime responsibility has put Atlas on target in 4000, 7000, and 9000 mile flights.

In all of its test flights the guidance has neither experienced nor been the cause of a single failure. This reliability record has been accompanied by large reductions in manufacturing cost.

Charles Perelle, who heads Arma and has personally put teeth in cost improvement and reliability programs, tells how it was done in the Atlas system. He has said modestly that "corporate management only established objectives, showed the way . . . operating management produced the results."

gether and discusses reliability problems with them. Problems range from specifics to overall company problems. To make sure this education is effective, supervisors themselves must undergo intensive training. The Training Section runs these courses.

Program Objectives—Here is the prime objective of our Atlas reliability program: Assure that the Missile Guidance System (MGS) is designed, manufactured, tested and delivered in such a manner that the probability of successful operation equals or exceeds the government specifications. To do this, we divided the program into three areas.

- Control
- Evaluation
- Reporting

Control—Control activities are mainly review of equipment designs and looking over engineering, manufacturing, subcontractors, and field service activities. We want to find out whether the design is conservative; also, whether margins of safety have been properly selected. Review of data also provides information on performance consistency. Such constant review is maintained over inspection and quality control procedures for optimum results.

Evaluation—Comparative evaluation of adequate samples of parts, major components, and systems is vital to the overall program. We want to find the most reliable parts as well as the least. Also, we search for reliable alternates. What we call "flight proofing tests" are performed under operational environment.

Reporting—We believe that a reliability program is only as good as the reporting system that makes the findings known to the right people. Arma's reporting technique is geared to provide timely and complete collection, analysis, and dissemination of failure and operating time data. It covers every area of activity from receiving inspection of parts to final flight test of the system. Data is continually analyzed to provide a feedback for corrective action by engineering.

The Organization—Now what kind of an organization structure, and what kind of people make this system work?

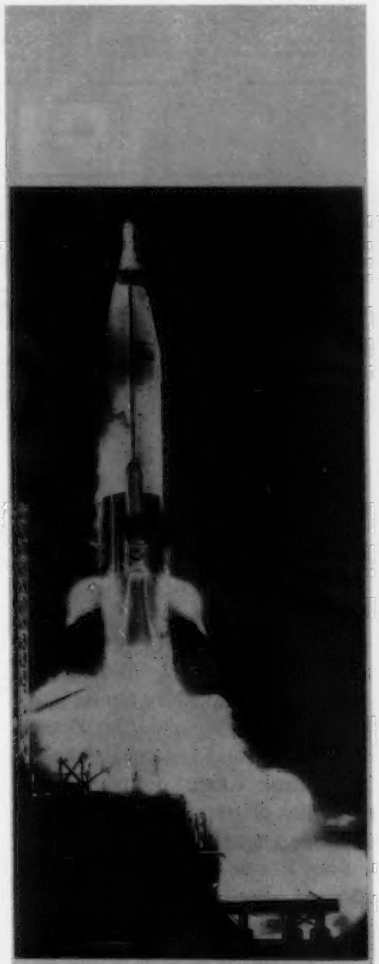
Product Reliability enjoys department status. The department head, John Cammarata, reports directly to the Assistant Div. Manager. The department comprises the following sections:

- Reliability Section
- Inspection Section
- Quality Control Section
- Certification Section
- Calibration Section

The Reliability Section Head is Stanley A. Rosenthal, a graduate of City College of New York (BEE) and N. Y. University (MEE) who has more than 5 years experience in product reliability.

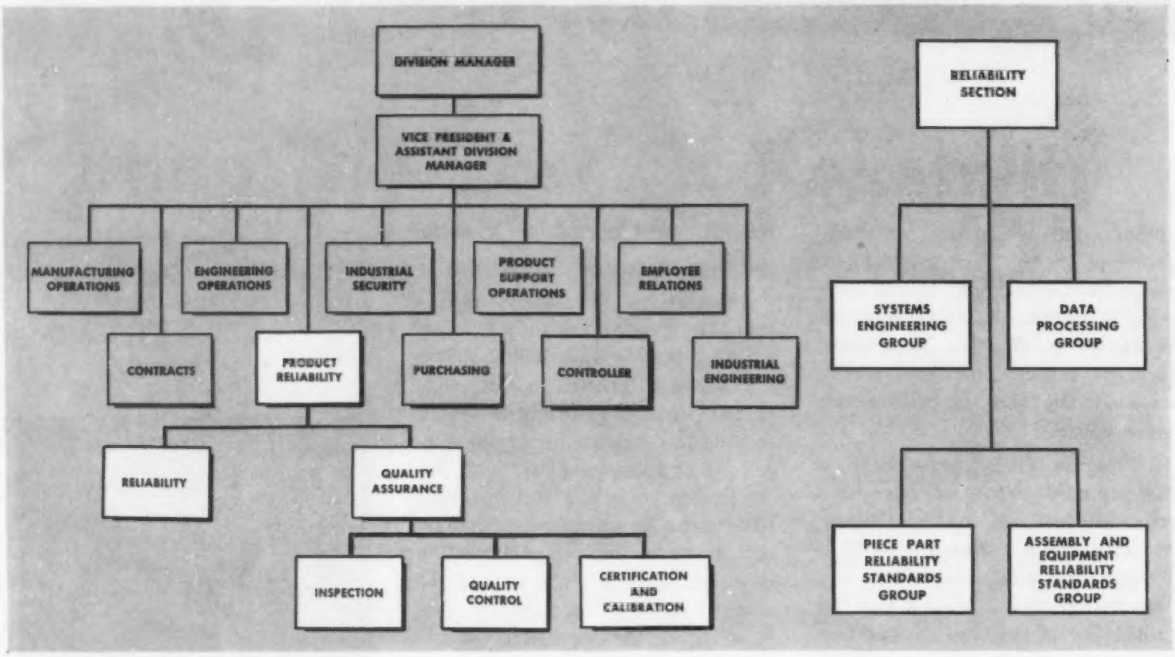
His areas of function and responsibility encompass the management of four groups:

1. Systems Engineering
2. Data Processing



Arma guidance keeps Atlas on target while CIP keeps cost down.

ORGANIZATION OF THE ARMA DIV. AND ITS RELIABILITY GROUP



3. Assembly and Equipment Reliability Standards
4. Piece Part Reliability Standards

How Reliability Control Works—Reliability control in the Atlas guidance is effected by constant review and surveillance of design, manufacture and test operations.

Control action dominated the reliability effort in the early stages of research and development. It has not lessened as the program has matured. But, it has been supplemented by special programs and field-use experience.

In reliability review, all the data that calls out the physical and functional features of the missile's guidance is subject to study. This includes: (1) Original design data, (2) Design Changes, (3) Equipment Specifications, (4) Test Procedures, (5) Environmental Specifications, (6) Procurement Specifications, (7) Technical Manuals.

The Reliability section has authority to veto any engineering action, drawing or specification in original design if the Reliability Review indicates this is warranted. All engineering changes also require Reliability approval.

Every Equipment Specification, General Environmental Specification, and Detailed Test Procedure, is reviewed by Reliability Engineers. Review of specs has three major objectives.

1. Assure that environmental tests will reveal any potential trouble area in the most severe operating conditions.

2. Assure that inspection and acceptance requirements will adequately detect weak spots.

3. Assure that design requirements are accurate and complete enough to achieve reliability goals.

Reliability Surveillance—Development, Production, Test, and Field Operations are all monitored by the reliability surveillance activity.

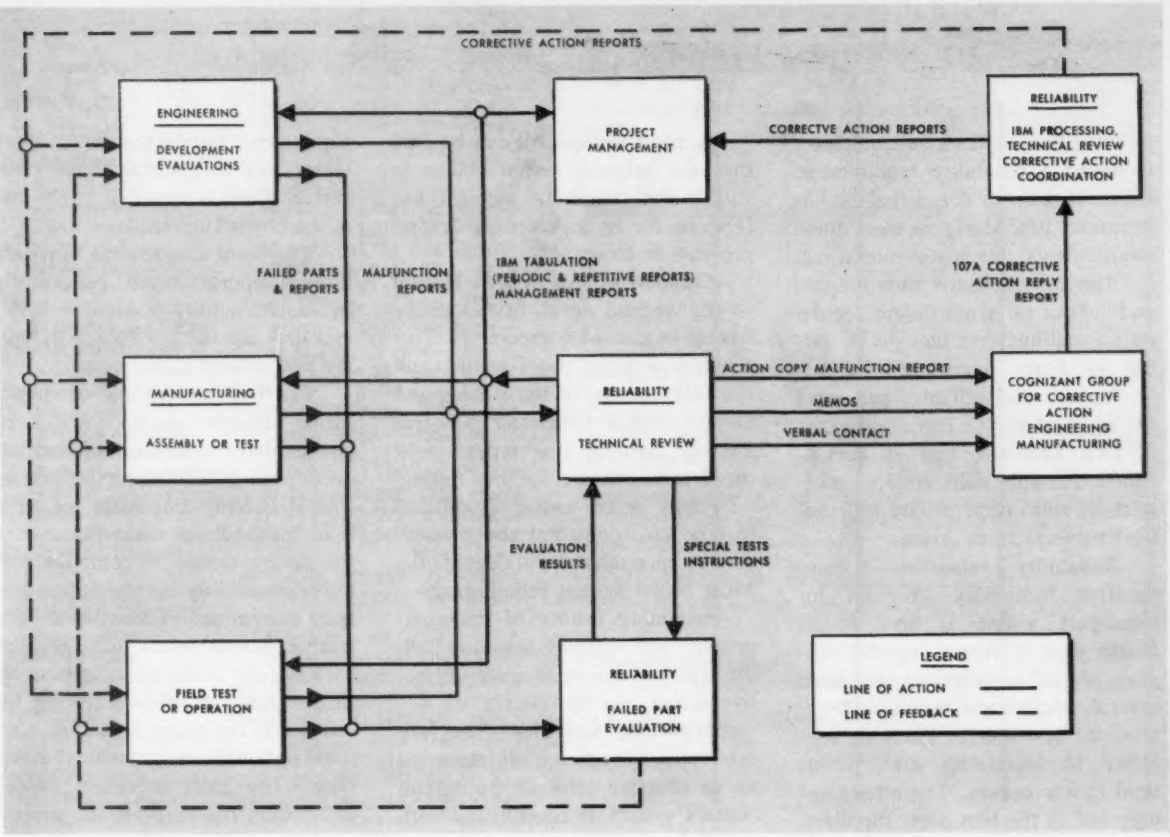
In Engineering, an important surveillance area lies in monitoring developmental tests when there have been untried physical changes made in the design. These changes might include new materials, or new physical arrangements of older materials.

Reliability personnel directly interpret all test results.

Though they do not directly interpret flight proofing test results, they monitor the tests and see that results are interpreted for their reliability implications.

In Manufacturing, a daily surveillance puts reliability engineers in constant touch with Arma-built assemblies, and their integration

MALFUNCTION REPORTING AND CORRECTIVE ACTION FLOW DIAGRAM



with procured assemblies.

When a reliability engineer spots a manufacturing operation that he thinks should be changed, an advanced Change Request is expedited through. This is followed by a normal Engineering Change Order.

Quality Control (QC) personnel evaluate each rejected part. They determine the best way to replace, repair or retest. We have established such a strong coordination between QC and Reliability engineers that corrective actions are often implemented to alleviate even potential problems. We don't have to wait for a failure or rejection.

The entire area of reliability control during manufacturing and testing is aided by having Reliability, Quality Control, and Inspection within one department. Thus, the Product Reliability Department acts with authority and efficiency.

Testing Parts, Components, Systems—During manufacture, each part or piece of equipment goes through a 100 per cent acceptance test. The data generated from these tests are then correlated with various engineering tests to see that reliability is consistent with what was expected.

These mechanisms have been set up for the control of all Vendor items intended for Atlas use:

1. A defective Material Report is sent to a vendor when a purchased part has caused trouble. A "Vendor Hold Order" prevents further procurement from this vendor until he straightens out the trouble. In addition we have a vendor rating plan. A monthly report is issued by vendors on three points: (a) Quality, (b) Delivery, (c) Service. Rating is simply: Good, Acceptable, or Not Acceptable.

2. Copies of quality reports on incoming components are serialized and kept on file for reliability investigations.

3. Multiple inspections can be effected on incoming materials at the discretion of QC.

3. Multiple inspections can be effected on incoming materials at the descretion of QC.

4. Reliability engineers always assist in the negotiation with vendors.

5. Reliability Section Coordinates all acceptance problems and aids QC in solving problems.

6. A Vendor Surveillance group has been set up within QC to monitor Vendor Test activities and QC procedures.

Assemblies and major components receive similar detailed tests.

All Atlas guidance equipment that is subcontracted is also subject

to surveillance. Each subcontractor is issued a reliability requirement. He must show evidence that he has instituted procedures to meet these requirements. He is also monitored.

The subcontractor must prepare and submit to Arma failure reports on all malfunctions that occur during Air Force Acceptance Testing.

Vendor Surveillance personnel are assigned at Otis Electronics Div. of Otis Elevator, and at Perkin-Elmer. Periodic visits are also made to these subcontractors by Reliability Engineers from Arma.

Reliability Evaluation—A comparative Reliability Program for piece-part testing is now in its fourth year at Arma. In this program critical parts are selected from several vendors and tested to determine the best source. Parts are subjected to increasing stress levels until failure occurs. These tests not only tell us the best parts suppliers, but also tell us if our Engineering Dept. is initially "calling out" what is best for our guidance system.

Some typical results show the following:

- Blowers — Two were tested. The findings of the reliability department were contrary to the original choice of the designer. Naturally, we switched to the better blower.
- Servo Motors—Several vendors were evaluated as sources of Mk-14 and Mk-8 servo motors. In each case the designer had specified a first and second choice. The findings of the reliability group were in exact agreement with the choice of the designer.
- Capacitors—In testing glass, mica, and ceramic capacitors for catastrophic failures, it was found that no significant difference existed in the products of our selected vendors. The specified preference of the designer was not incorrect in this case, neither was it wholly correct.

In most instances it can be said that the original design choice is valid. But, there are enough exceptions for us to keep our testing program in force.

Component and System Testing—The second level of reliability testing is that of components. This consists of flight proof testing and reliability testing of the Analog and Digital Signal Converter. System Testing involves two types: flight proof testing and reliability testing.

Flight proof testing establishes that no environmental stress which may be encountered will degrade the MGS below system requirements.

Reliability testing of the components and systems generates failure data on which effective corrective action can be taken.

Reporting Activities—The failure reporting system is all important to an effective reliability program. Arma's system is coordinated with BMD, Space Technology Labs and the Associate Contractors on the Atlas Guidance.

In addition to the failure reporting system Arma has a system for recording and reporting the operating time on all major components.

Various forms have been designed for the complete and rapid recording and understanding of test results.

Arma Failure and Consumption Data Report is a modification of AFTO Form 120. It goes beyond the data required by Air Force.

Non-repairable piece parts are recorded on Failed Piece Part Analysis Form 40-463. Analysis data restored on punched IBM cards.

A Correction Action request form is used to set the wheels in motion when review indicates a situation is growing which tends to degrade reliability. The information is also stored on punched IBM cards when complete.

Operating Time records are kept on the MGS, Ground Support Equipment, the Analog Signal Converter, and the Digital Signal Converter. Time is recorded at the end of each working shift.

There are also several summary failure reports issued periodically by the Reliability Section. In general they are IBM print-outs of failure and related data.

The Engineering and Manufacturing design groups must, of course, have complete information on failures to take corrective action. The Reliability Engineers see to it that this feedback takes place after the failure review is complete and the responsibility for the failure has been determined. Likewise, a Corrective Action report must be sent back to the Reliability Section by Engineering or Manufacturing in order that the status board on outstanding problems remains complete. The most important aspect of "closing the loop" is the proper corrective action. It must improve the reliability of our guidance system.

Tangible Results — Now what has been the effectiveness of this stringent reliability program?

The inertial system has guided Atlas on 4000, 7000, and 9000 mile flights. The 9000 mile flight was on July 7, 1961, and spanned the distance from Cape Canaveral to the Indian Ocean.

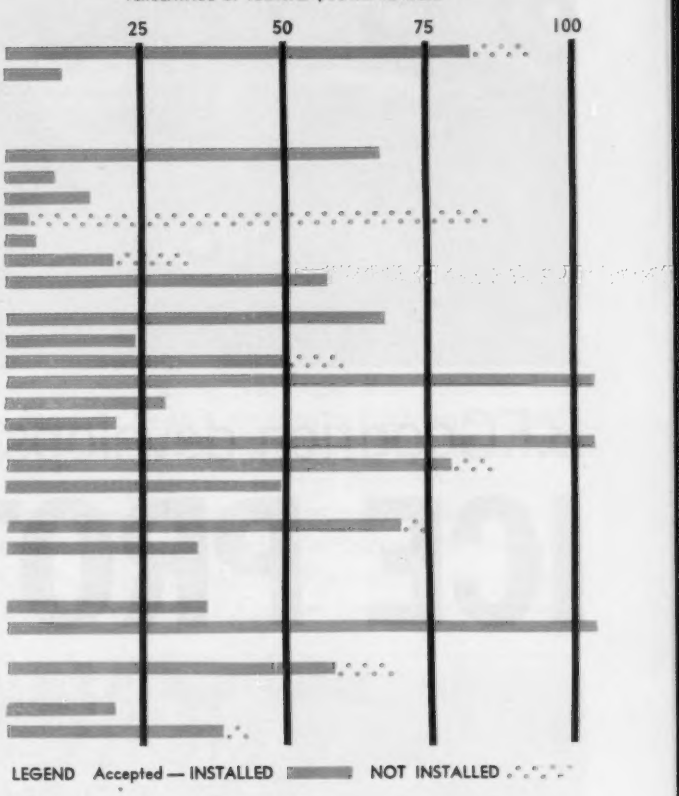
How About Cost?—Has all this reliability cost us money or saved us money? It has saved all the way around. From the standpoint of no-failures we have effected savings. And from a broad side attack on costs by management we have been able to constantly effect savings while improving reliability.

All of Arma's management personnel participate in a Cost Improvement Program (CIP). In 1959 this program resulted in $1.5 million in savings. In 1960 savings exceeded $3 million; this topped our target which was $2.3 million.

COST IMPROVEMENT PROGRESS REPORT

DATE ISSUED 7/10/61 MONTH—JUNE

DEPARTMENT	1961 QUOTA	ACCEPTED $ Value All Sources	%	INSTALLED $ Value	%
CONTRACTS	$ 28,100	25,844	92	22,676	81
CONTROLLER	91,755	9,981	11	9,981	11
EMPLOYEE RELATIONS	22,935	0	0	0	0
ENGINEERING					
Administration	26,840	0	0	0	0
Development Serv.	98,158	63,692	65	63,692	65
General Projects	44,487	3,214	7	3,214	7
Inertial Guidance	282,872	40,093	14	40,093	14
Product Design	99,540	81,962	82	4,418	4
Research	39,515	2,143	5	2,143	5
ENGINEERING TOTAL	591,412	191,104	32	113,560	19
INDUSTRIAL SECURITY	9,230	5,105	55	5,105	55
MANUFACTURING					
Assembly & Wiring	102,765	69,259	67	69,259	67
Hicksville	41,107	9,763	24	9,763	24
Machine Shop.	123,318	70,228	57	61,857	50
Precision Assembly	143,871	179,695	125	179,695	125
Plant Engineering	79,900	22,717	28	22,126	28
Production Control	113,762	23,915	21	23,915	21
Product Services	11,942	51,848	434	51,848	434
Test	171,075	151,999	89	134,834	79
Tool & Process	55,090	26,535	48	26,535	48
MANUFACTURING TOTAL	842,830	605,959	72	579,832	69
PRODUCT RELIABILITY	153,900	52,019	34	52,019	34
PRODUCT SUPPORT					
Base Activation	27,946	601	2	0	0
Field Service	20,024	6,964	35	6,964	35
Field Evaluation	15,000	33,599	224	27,598	184
PRODUCT SUPPORT TOTAL	62,970	41,164	65	34,562	55
107A PROGRAM OFFICE	6,098	0	0	0	0
PURCHASING	690,770	127,018	18	125,880	18
DIVISION TOTAL—1961	2,500,000	1058,194	42	943,615	38
From Previous Years	(Balance)	160,585		23,746	
TOTAL 1961 PROGRESS		1058,194		943,615	



This year the target is $2.5 million. Through June, $1.06 million of this has been programmed and $943,-615 actually realized.

Now how does CIP work? First, it is a rung above the typical suggestion award program in effect here and at many companies. CIP is restricted to management personnel. Personnel on the supervisory level and above.

There are no cash awards. Cost cutting is a normal management function. It is an expected thing. CIP and management thrive on competition.

Each department receives a quota. Reaching or exceeding this cost reduction quota is the goal. Recognition is the reward, individual recognition and department recognition for a job well done.

Industrial Engineering (IE) administers CIP. Anyone in management who has an idea about cutting operating costs fills out a CIP form and submits it directly to IE. The idea is not to foster cut-throat competition. The idea is to remove all obstacles to free thinking and free submission of ideas.

A CIP is evaluated first by the Standards and Cost-Improvement Section in IE. It then goes to the CIP analyst who has the full-time job of evaluating the suggestion and getting more details from the originator if need be. The analyst then takes the suggestion through the affected departments to see if it will actually work. The last step for the analyst is to get a Cost Analysis. How much will this suggestion actually save?

The idea is then formally submitted to a weekly meeting of the CIP committee. If accepted, the submitter is notified through his superior and a copy of the notification is inserted in his personnel jack. It is there as a permanent record for salary adjustment and promotion review.

Other savings on Atlas guidance have been realized by a reorganization of our procurement function and establishing our subcontracting activity as a specialized section under the Purchasing Agent. Experienced subcontract Buyers have been placed in this section. The action has substantially strengthened our subcontracting activity.

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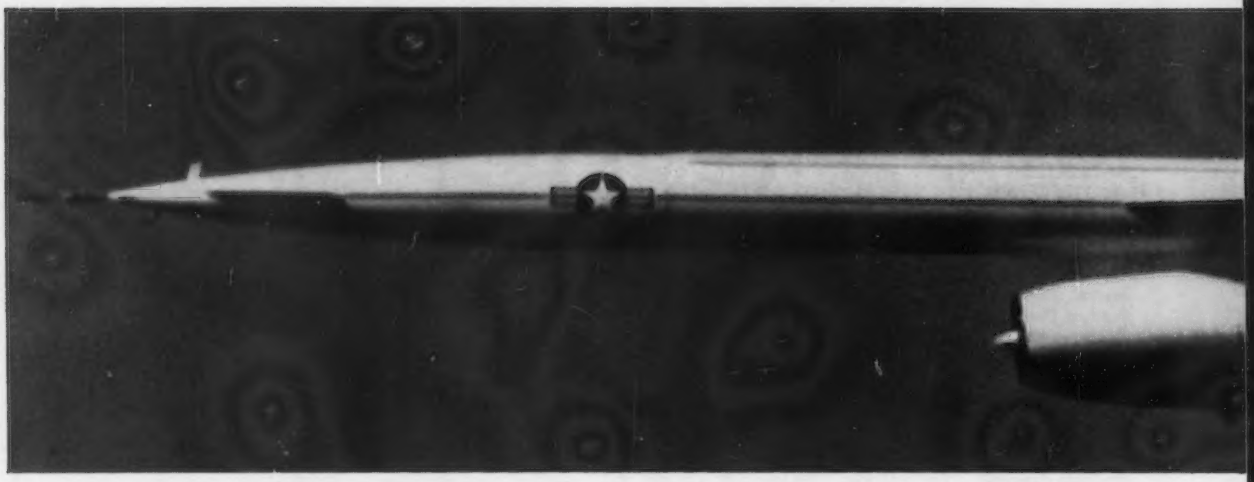
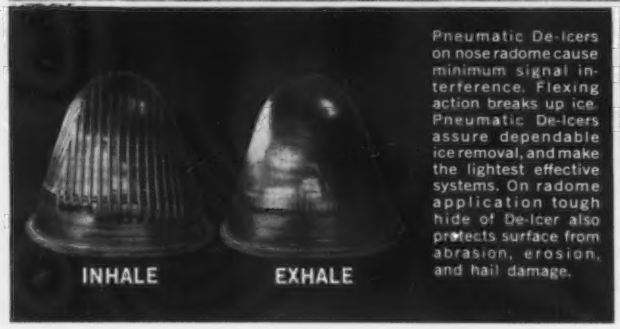


B.F.Goodrich develops versatile systems for
ICE PROTECTION

HIGH PRESSURE PNEUMATIC DE-ICERS equip the wing and tail leading edges of Lockheed C-140 JetStar. System was chosen for light weight and simplicity.



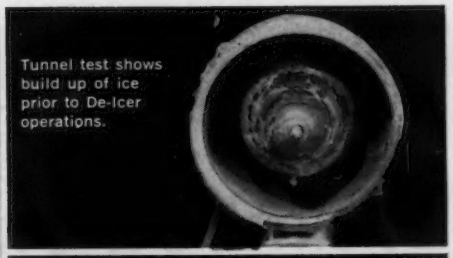
Pneumatic De-Icers on nose radome cause minimum signal interference. Flexing action breaks up ice. Pneumatic De-Icers assure dependable ice removal, and make the lightest effective systems. On radome application tough hide of De-Icer also protects surface from abrasion, erosion, and hail damage.

FLYING TV specially equipped casts. Two pneumatic 23-foot antenna.

ANTENNA is kept ice-free on this DC-6AB used for educational broad- De-Icers cover the leading edge of the Pressure is cycled in spanwise tubes.

ELECTRO-THERMAL DE-ICER SYSTEMS KEEP "HOUND DOG" NOSE WARM

To keep this North American Aviation missile's engine ready for instant launching despite freezing conditions, BFG electro-thermal units are installed on the nose cone, supporting struts and ram air probes.

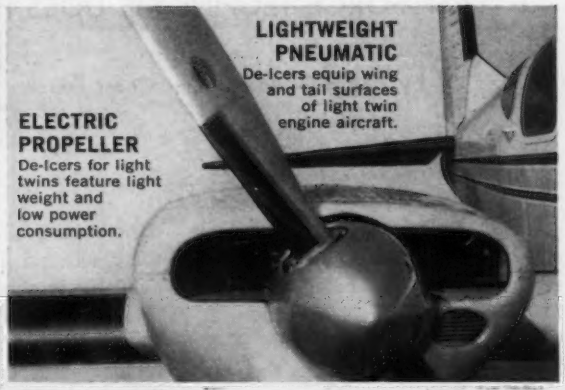


Tunnel test shows build up of ice prior to De-Icer operations.

Stainless-steel-clad heating elements protect engine air intake.

Since introducing the first pneumatic De-Icers for aircraft over thirty years ago, B.F.Goodrich has developed a broad capability in ice protection systems: *Pneumatic De-Icers* are used on high performance aircraft like the Lockheed C-140 JetStar...and designed as lightweight systems for small twins. *Metal Clad Electro-Thermal De-Icers* can be adapted to airfoil shapes, and in many cases can serve as structural members. *Heated Rubber* is adaptable to fit complex curves or odd shapes for localized heating. *Reinforced plastic parts*, integrally heated, are available for applications not subject to severe abrasion. Whatever your requirements in eliminating or controlling ice bring them to BFG...the leader in De-Icing. For information contact *Dept. AM-9, B.F.Goodrich Aerospace & Defense Products, a division of The B.F.Goodrich Company, Akron, Ohio.*

"HAIL-SAFE" DE-ICING is provided on empennage of General Dynamics/ Convair 880 by BFG Cladheat electro-thermal De-Icers. Stainless steel skin withstands abrasion from rain, dust, even hail at high cruising speeds. Six-foot Cladheat sections are bonded to leading edges to form a smooth, integral airfoil.



LIGHTWEIGHT PNEUMATIC De-Icers equip wing and tail surfaces of light twin engine aircraft.

ELECTRIC PROPELLER De-Icers for light twins feature light weight and low power consumption.

HEATED RUBBER bonds securely to complex curves and odd shapes as well as flat surfaces. Integral electrical heating elements control ice formation in areas such as air intakes and cowls, or provide heating for power units.

B.F.Goodrich

aerospace and defense products

Lockheed Smashes BOTTLENECK

In Test-Data Reduction

- Polaris cut new swath in rocket technology, so design effort hung heavily on test data reduction and evaluation.
- Normal cycle was cut from five weeks to ten days.
- TASK-FORCE TECHNIQUE DOES IT . . .

by **Philip Geddes**, West Coast Editor

The Polaris missile program still has high priority. Range of the operational A-1 is being extended to 1500 mi in the A-2 version. It will reach 2500 miles in the A-3. During mid-development, the urgency of the program forced prime contractor Lockheed to cut the test-data reduction and evaluation cycle from five weeks to ten days. This was done by using a "data task force" approach.

Data Analysis Cycle—In the early stages of testing, data could be evaluated quickly. This could be done because the number of people with top design responsibility was small. In 1956-57 only about 50 people were involved.

As the design effort grew, the time from test-data-receipt to design-decision also grew. A five-week bottleneck was created.

Let's look at the data analysis cycle used in 1958. Starting from the test-base block marked T-O, in the diagram a final data report was available in about seven days. After this report on the telemetered data was generated, a "quick-look conference" was called. At this point the results were examined by a cross-section of the "interested parties," including: sub-system design personnel, test planners, quality and reliability assurance, customer and associate-contractor representatives.

Preliminary test results were passed, on a strictly-informal basis, through the chain-of-command. This included division-level managers, such as the manager of test operations, up to the directors of the program. As with any other development program, key design decisions were made on basis of evidence gathered as testing progressed. The quick-look conference also served as a focal point for forming working groups of design engineers to pour effort into complex problem-areas. Such groups included aerodynamicists, structural engineers, telemetering experts, etc. The exact make up depended on the nature of the problems. Design fixes not requiring group-analysis were initiated at this point in the data cycle.

Polaris Not Simple—The Polaris, despite the apparent simplicity of a solid-propellant motor is still a complex missile. The number of people engaged in design analysis after a firing was high, sometimes in the hundreds. In essence, each sub-system design group prepared its own findings. Final conclusions had to be delayed until all data could be gathered together. Evaluation work ended in a test analysis report, due contractually, five weeks after the test.

During the period up to publishing the report, new findings were reported progressively to management, the Navy, and associated contractors. These findings created appropriate design decisions to insure a properly-modified vehicle for the next test-flight. Obviously, the five week data evaluation cycle could not be tolerated for long, if the operation phase was to be achieved quickly. The Navy needed Polaris, and Lockheed set to work to improve program-management in data evaluation.

Evaluation Accelerated — The concept for digesting data rapidly and efficiently is shown in Polaris Flow Chart—1960. In essence, this system brought down the number of people doing the decision-making to the workable level known very early in the program. Final analysis is now available in 21 days; important findings requiring group-action are discernible in as little as two days.

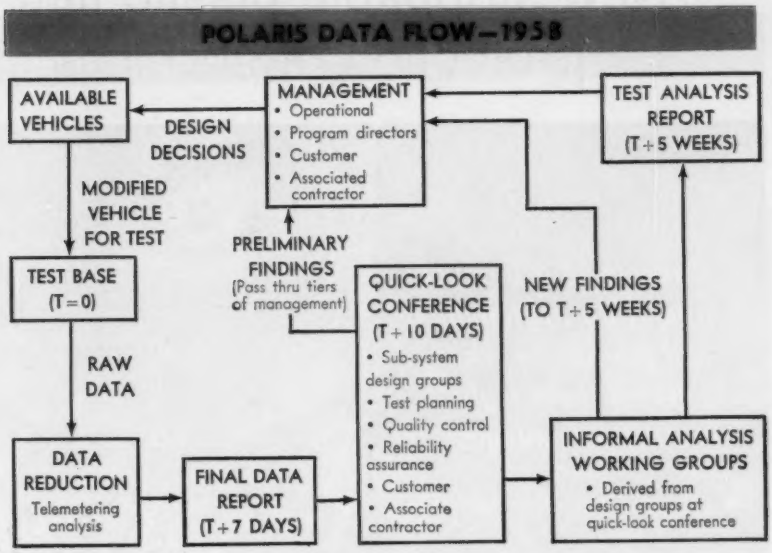
Data task force operates on a day-to-day basis after T—O, in a conference room set aside as an

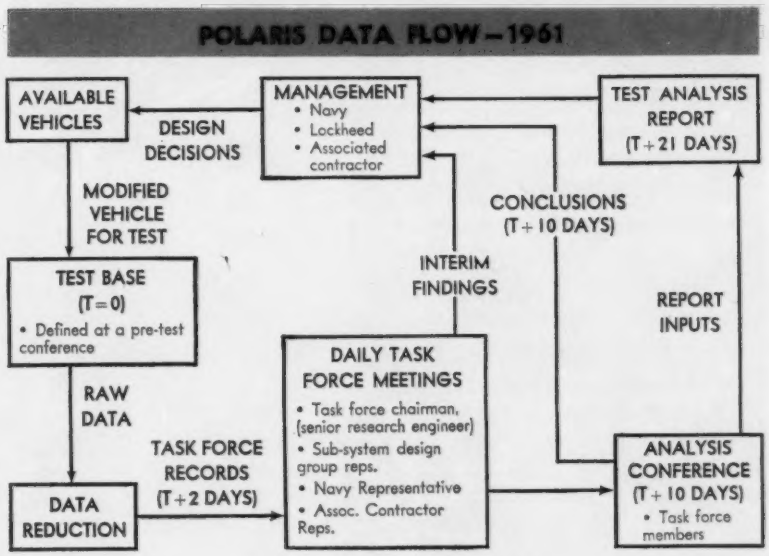
"analysis center." Each sub-system design group, the Navy, and associated contractors are represented. Test information from the 250 parameters usually tested on Polaris, include: acceleration, motor-chamber pressure, temperatures at various locations, flight-control-system voltage-monitors, telemetering monitors and so on. These funnel into the analysis center in bits and pieces. In general, this information is not in finally-calibrated form but is useful for indicating trends.

The task effort is not a mass-education program. It is an attempt to simplify communication between key design-groups. A dual role is being played by the individuals concerned: analyzing for today and designing for tomorrow. Before the task force was created there were many more people participating. Consequently, it was more difficult to be definitive in the areas requiring attention.

Day-to-Day Decisions—Formal daily meetings in the center, direct effort to a final meeting of the daily task-force group to a final meeting, called an analysis conference. This is scheduled for T+10 days. No attempt is made at T+10 to make a formal report as before. Day-to-day minutes are kept and the boundaries of the daily task-force group interest established. As a matter of course, each member becomes aware of his own particular field of interest. Interim conclusions are often published after the first meeting, to keep all levels of management informed.

At T+10 the analysis conference of task-force members is called by the task-force chairman, usually a specialist such as a senior research-engineer. He is appointed by section or primary supervision to ride herd on the analysis group. All the information generated at the task-force meetings is presented.





Any remaining areas in question, or subject to conflicting opinion are resolved at this point. Conclusions are formed for consideration by all those present. The final Missile Test Analysis Report is derived from the findings of this meeting.

The task force chart shows the system coming into effect at T—O. When Polaris A-1 testing was at its height, a pre-test conference was held by a group made of representatives from sub-system design, test planning, quality and reliability assurance, customer, and associate contractors. It was a larger version of a similar group which worked all the way through the data evaluation task, before the system was streamlined and the task force approach introduced. The pre-test conference aim is to align up-and-coming tests already on hand, and probe potential problem areas. Each flight was then a new experiment. This pre-test phase is now receiving less attention.

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Administering Value Analysis

- *Attention to these key points spells the success of a value effort:*

  (1) Group Activity—use know-how of Engineering, Manufacturing, Purchasing, and Quality Control.

  (2) Sustained Effort—avoid spastic progress and pitfalls.

  (3) Vendor Assistance—learn to listen to specialized advice.

  (4) Part Function—know what a part does and why you need it before trying to cut costs.

  (5) Objectivity—bar "pride of ownership"; it hampers progress.

● This is how Sperry does it . . .

by David Fram,
Value Analysis Admin.
Sperry Gyroscope Co.,
Div. Sperry Rand

Organization of Value Analysis effort in a company is the decisive factor in the success or failure of a value program. This problem was faced by the Sperry Gyroscope Co. when Value Analysis was implemented on a company-wide basis in July, 1960.

Sperry's value program started with the appointment of a Value Analysis administrator reporting to George Richroath, vice president for manufacturing, headquarters staff. The administrator was assigned the following duties:

- Aid the divisions to implement value analysis.
- Disseminate results.
- Formulate long-range objectives.
- Develop procedures manuals.
- Keep the program active.
- Maintain coordination.
- Recommend training courses.
- Assist the divisions in conducting seminars.
- Represent Sperry on industry committees.

We first studied what other companies had to offer; then took a close look at what we were already doing. We decided to establish value analysis in the divisions with the following features:

Group Activity—Due to the complex nature of products involved, successful cost reduction through value analysis could be obtained best through joint effort. This meant participation by Engineering, Manufacturing, Purchasing and Quality Control. The overall technical problems in such products as complex military systems are beyond the intellectual scope of any one individual. Secondly, there aren't enough "technical Dale Carnegies" to handle the human-relation aspects of such activities.

Full-Time Effort—Value Analysis is a full-time effort for an assigned period.

Value Expert D. Fram
listening for savings

Many years of experience with cost-reduction committees meeting once a week or once a month gave us cost reduction—but not enough to meet today's brutally-competitive market. On the other hand, we wanted to avoid new job titles, departmental hierarchies, and the disturbance of direct to indirect ratios. Hence, we decided to use the people we had with their existing job titles and lines of reporting.

Value Analysis teams are assigned to specific products for definite periods of time, with goals of cost reduction to be attained. The team members are selected from Engineering, Manufacturing, Purchasing and Quality Control. Some products can justify a team consisting of a single member from each of these four groups. In other cases, teams may function with one representative from Engineering and one from Manufacturing full time, with part-time participation from Purchasing and Quality Control. Regardless of the number of team members, the full-time participants are removed from their normal duties during an assigned period; they concentrate on nothing but cost reduction through value analysis. Upon task completion, the team members are returned to their former jobs. These teams have no authority to make changes. Their job is to study the product or design and make recommendations to those in authority to make changes.

Vendor Assistance—The Value Analysis teams must use vendor assistance. Analysis of our product-costs usually shows that about 50 per cent of the sales dollar is spent through the Purchasing Department. We must therefore enlist the aid of our suppliers if value analysis is to make an appreciable dent in our product costs. Specialty suppliers have a vast fund of know-how that is available for the asking. Team members are directed to use vendor talent in every way possible; they must dispense with the inherited concept that we know it all. The secret, of course, lies in knowing how to listen.

Function-Oriented Effort—Finally, and perhaps most important of all, entire team-effort must be function-oriented.

In the past, our cost-reduction efforts have been concerned almost entirely with how to make it for less or where to buy it for less. This is not good enough. In fact, it puts the cart in front of the horse. We must concentrate first on what the part does, why is it used—in other words, what is its function? After the function is thoroughly understood and all practical alternatives are considered then we can talk about how to make it for less. Without this logical two-step sequence, we get 10 to 15 per cent cost-reduction instead of the 50 to 60 per cent we know is possible.

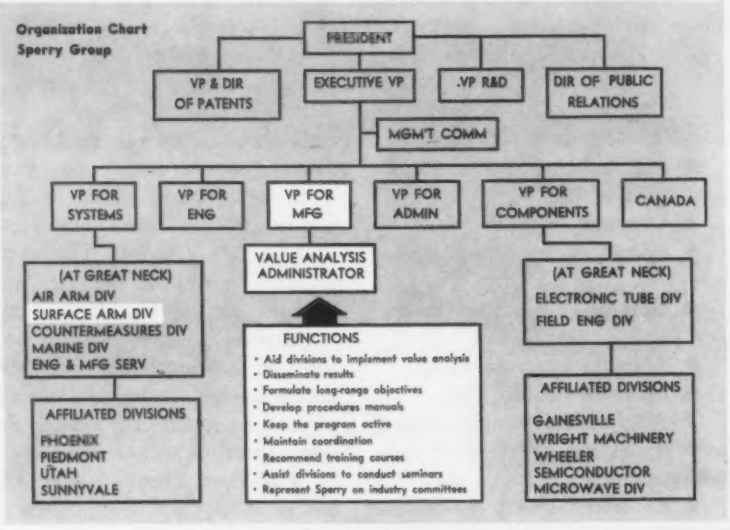
After the objectives of value program were defined, next task was to devise the value analysis organization.

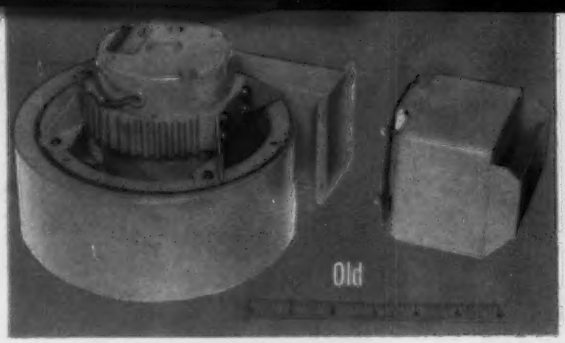
Let's refer to the organization charts of the Sperry Group, and the Surface Armament Div., to trace the Value Analysis administration responsibility. In the Surface Armament division, value analysis responsibility is assigned to the manufacturing engineering manager. Because this is a relatively large division, the manager has appointed a cost-reduction coordinator with full-time responsibility to organize and direct the Value Analysis team, measure and report their results, plan and conduct seminars.

Objectivity Is Vital—It has been our experience that value analysis is more effective when it reports to Manufacturing Engineering than anywhere else in the organization. This is so because manufacturing people can be more objective in their analysis of a particular design. The "Pride of ownership" of the existing design is not a factor. Also, they are the people normally concerned with make-or-buy decisions.

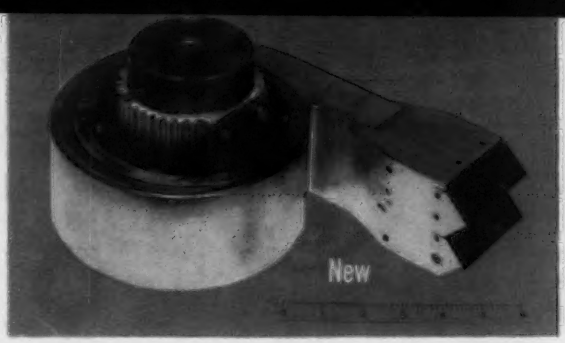
The coordinator at present has several products under value analysis study but let us now take a close look at the team assigned to a large missile tracking system. Here, the team consists of: a design engineer, a product methods engineer, a buyer, and a quality control representative. In this particular case, the design engineer and the product methods engineer are full-time; the others are part-time.

During the allotted time period for value analysis there is no change in the team members' titles, reporting responsibility, or direct and indirect status. As cost-saving changes are developed, recommendations are turned over to Engineering when product design is involved. They are turned over to Manufacturing when tools and operation sheets are involved. Buyer handles





Fan had two sub-assemblies before value analysis.



Integrated design saved $69,462, @ $8.44 per fan.

all matters pertaining to vendors and the Quality Control representative handles all questions of quality or reliability. Design department is called in when new layouts are needed. Shop participates in making models and the Test Department makes the qualifying tests. Materials and Components Group supplies information on standard alternatives and qualified sources of supply. Accounting department supplies historical cost data. Estimating Group provides cost estimates on new methods or alternate designs. Here is a sample of what the missile radar team developed.

Typical Case—Terrier missile radar team (Surface Armament Div.) reviewed a centrifugal fan assembly in a missile radar cabinet which had a primary function of cooling the cabinet. This fan consists of two parts.

One part, called the louver assembly, fits on the housing of the fan assembly with a Metex gasket and 4 screws and is made out of stainless steel. Louver assembly contains a honeycomb absorber-material to cut down on radio frequency noise. Cost of louver assembly is about $50.00, exclusive of tooling.

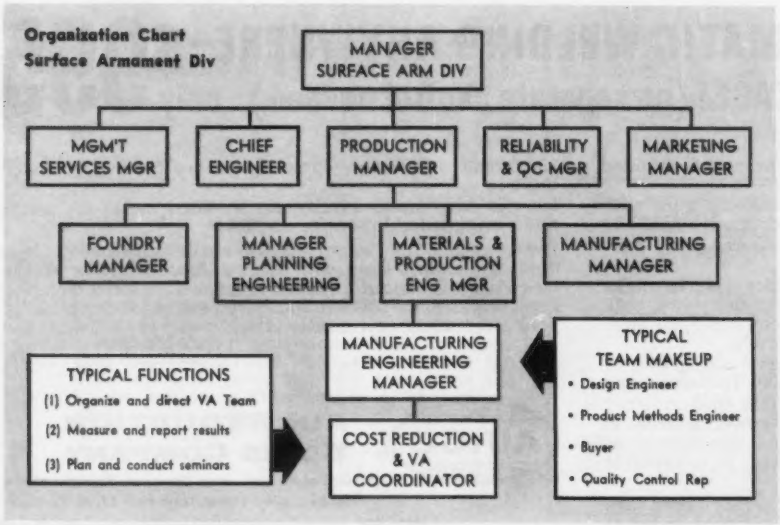
The other part is the main fan assembly, which is made of steel and spot welded. It costs $56.56.

At the completion of their review, the value analysts recommended that the louver assembly, consisting of 11 parts, be eliminated as a separate part. This could be done by installing the honeycomb absorber material in the housing of the main fan assembly. Thus, centrifugal fan assembly could be made as one unit. In addition, review of the fan assembly suggested a second improvement.

Assembly-Time Cut—Existing spider-application assembly on fan assembly had to be disassembled by the removal of screws, prior to installation in radar cabinet. This took 32 minutes in assembly time. In this case the team recommended that the spider-application assembly be welded on the inside of the housing of the main fan assembly.

Value team also reviewed a wiring assembly print which called for three leads cut to specific lengths and three lugs soldered to the leads. The review further reflected there were six different drawings for different lead-lengths. The team recommended the use of a standard length of wire with the lugs already soldered to the leads to satisfy all the radar cabinet requirements. Further, that this unit be purchased complete to eliminate any additional work prior to installation in fan assembly.

From the recommendations, the savings amounted to $8.44 per centrifugal fan assembly, or a total savings of $69,462.00 on present contractual requirements. It can be seen that the functions of the centrifugal fan assembly will still be performed as before. Hence, analysis did lower the cost of these functions, but did not sacrifice performance or reliability.



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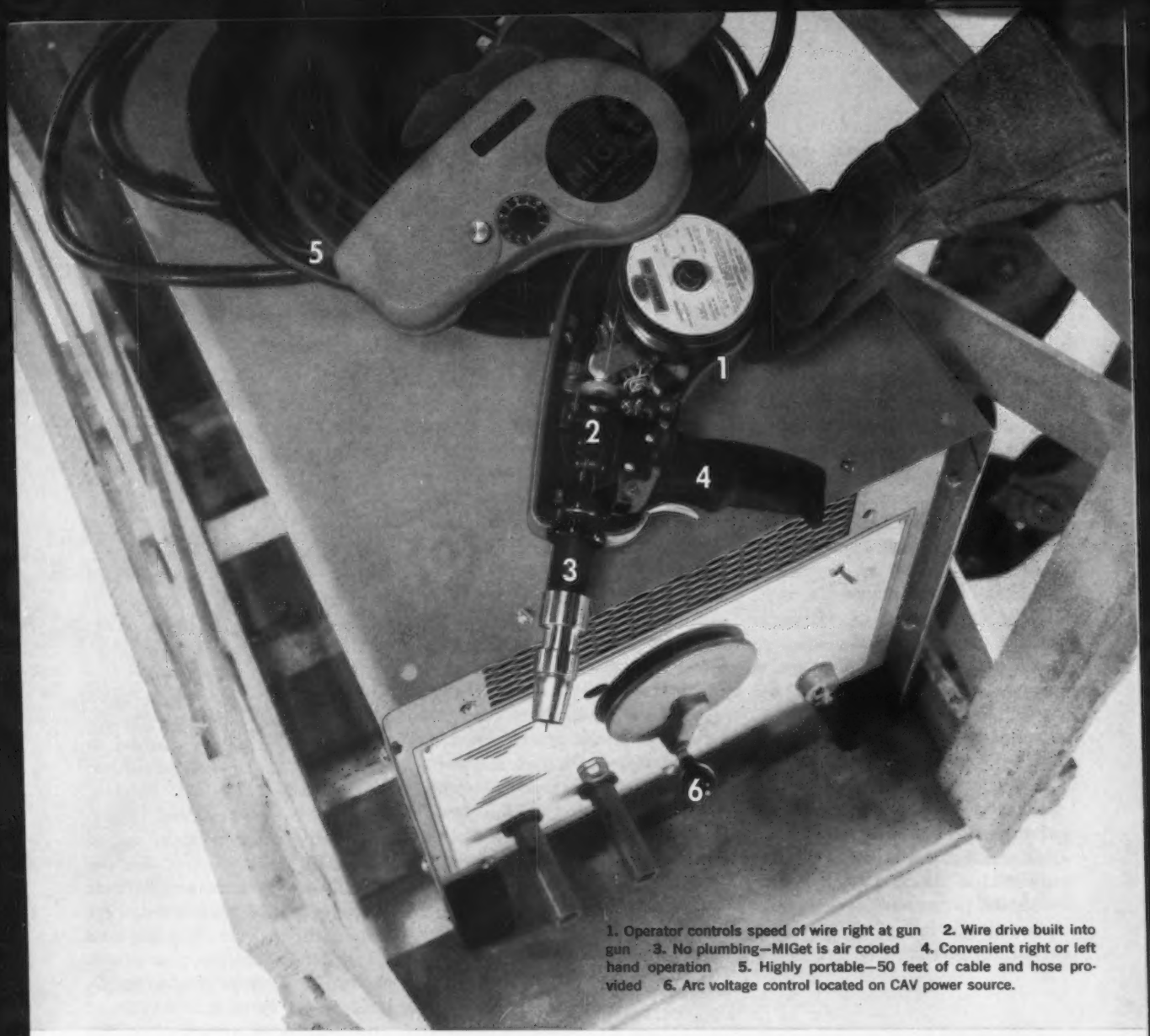

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How Good Is PERT?

- *Navy's highly-touted management technique is not without its critics at Lockheed. Here is what they say:*
  - *(1) Pert has not chopped four years from delivery schedules.*
  - *(2) Pert cannot operate in a crisis situation.*
  - *(3) Pert is not effective in day-to-day production.*
- *Pert has been very effective in advanced planning. Its lasting value is that it has disciplined reporting techniques.*

by **Philip Geddes,** West Coast Editor

Program Evaluation Review Technique (PERT) helped management at Lockheed Missile and Space Div. schedule Polaris development. But the help was more limited than some highly publicized events seem to show. PERT alone did not cut four years off an eight-year program. This has been suggested. "Many people think that any logical method of planning and allocating resources in time of shortage is PERT," states a PERT user. "If you anticipate your problem and apply a solution, some believe you have 'perted.' This is not true."

Pert and Polaris—Significantly, PERT does not compute costs for a project. What then is PERT and what has it meant to Lockheed on Polaris?

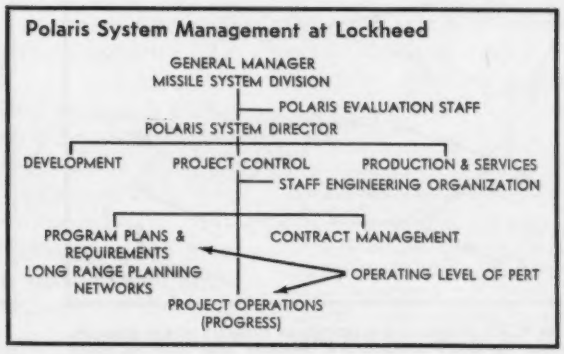
By Navy definition PERT, with time as the variable, provides:

- "A measure of current status against approved plans and schedules.
- "A forecast of future progress and problem areas with probabilities of meeting schedules for planned effort.
- "The effects of proposed changes in plans on established schedules for meeting program goals."

And how does PERT do this? Also by Navy definition, "At both the Special Projects Office and the contractor levels of management, complex subsystem development and component programs are monitored by PERT, usually on a biweek basis. This method has two basic requirements: a flow plan and elapsed time estimates."

Full implementation of PERT started in Sunnyvale close to two years ago. At first the program was a side operation with a small group developing procedures. Then, one year ago the PERT group became a line organization of 25 people, costing $500,000 annually.

What Management Says—Polaris operating managers interviewed by AEROSPACE MAN-



Management structure of Missile Systems Division at Lockheed-Sunnyvale shows the principal operating level of PERT (Program Evaluation Review Technique). Though PERT has been effective in Polaris and Lockheed spends $500,000 annually to keep it in operation, it has its critics. They say mainly that PERT has received too much credit for chopping four years from the Polaris schedule. Effectiveness of the system drops rapidly after first piece of hardware is delivered they say.

← Circle 15 on Inquiry Card

AGEMENT agreed generally that PERT has been a useful tool for orderly and disciplined planning. They list several points in favor of the system:

(1) PERT causes a discipline in planning previously not often present. Planners are forced to do a detail step-by-step layout of a several year program. This takes the vagueness out of the day-by-day accounting of time. Where a formal system of such planning is lacking, PERT will do well.

(2) PERT benefits absentee managers by use of a consistent reporting format. Lockheed and the Navy are some distance from several major contractors in the Polaris program. PERT reporting done on a weekly basis highlights problems weekly until they are solved. The reports are easy to understand in addition to being uniform.

(3) The basic PERT format may be more valuable in the future with a cost dimension added to the time factor. Lockheed is working on a "Work Assignment Plan" which will go to work in the engineering and design departments at four or five levels down from general management levels of PERT.

(4) PERT format is a good one for visual presentation to management. It is a considerable aid in blowing up problems for management action. It has increased the total number of people who regard Polaris as a system and not as a fragment of a system. PERT in this case is acting as a vehicle for synthesis.

What PERT Has Done—The following are examples of what PERT has accomplished "in fact." The scantiness of the examples given is due to security.

(1) The system showed that the fiberglass second stage case for the A-2 missile would be delivered too late to meet firing program schedules. The subcontractor to Aerojet General for the cases had to turn from normal 40 hr/week production to extra shifts in order to meet schedule.

(2) On design of the trajectory control system for an advanced system, PERT networks showed that time for commitment to a design had arrived. Parallel development could be discontinued.

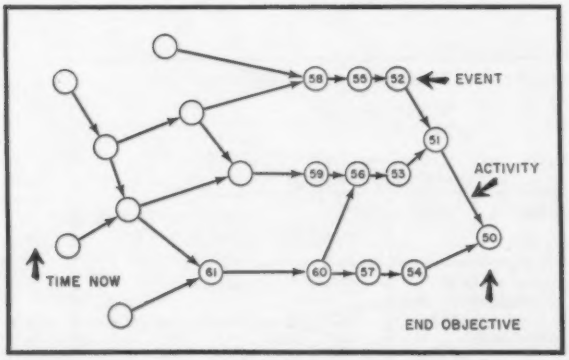
(3) Analysis indicated that if Lockheed and the Special Projects Office waited until all the criteria for an advanced model flight became available before releasing requirements, schedule would suffer. Incremental release of the criteria allowed design projection to start procurement of long peacetime items such as checkout equipment which would have to be specially designed.

Critics of PERT—On the slightly critical side, Lockheed operational management closest to PERT say that perhaps the Navy, the customer, has done better with the weapon system than Lockheed, the missile contractor, has done with the missile system.

PERT does well during advanced planning and up to the delivery of the first article. Then, management has to switch to a production reporting system such as "line of balance" which is a primary reporting device consistent with Lockheed systems in management. If the Department of Defense says it wants to see a management system in a given period of time, any contractor is going to install a system. Something like PERT is laid out to match a desired operational date which in itself is made on considerations of time, politics, international tension, adding up to need, and money available. Change something like the operational time desired and the whole system has to be revamped.

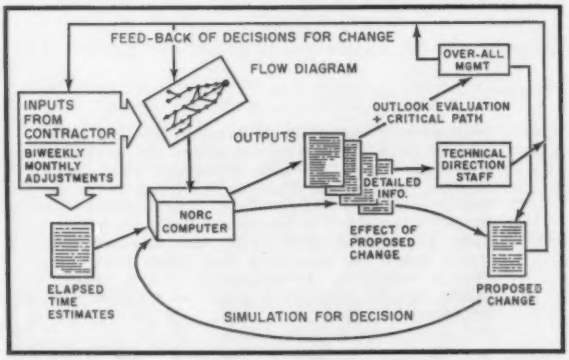
"PERT cannot function in a crisis situation with such things as

BASIC PERT NETWORK



Circles in PERT diagram are points in time at which specific tasks start or end. Arrows are amount and kind of work between events.

PERT IN OPERATION



Two-way flow of information between Navy Special Projects, prime and subcontractors, and in-plant management funnels through computer at NORC, Dahlgren, Va.

double shifts, 60 hours a week, and so on."

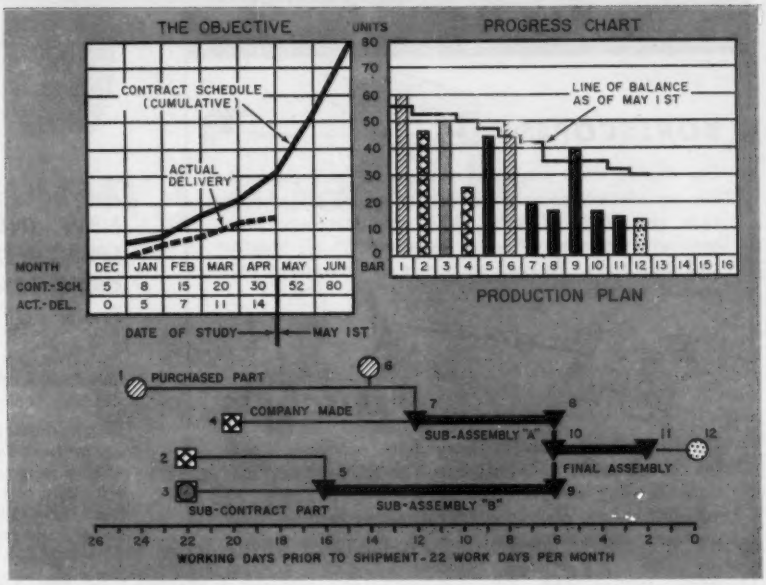
"PERT tells you what you have told it originally—your judgment is fed back to you. The inputs are based on your intelligence. No corrective actions are developed by PERT. So far there is no substitute for judgment, intelligence and background."

And again, "The best scheduling is done by people in planning who have knowledge of the program and the company. A three time estimate is not necessarily better than these planners. PERT is best used by these people as a line function and not installed separate to the planning group."

These remarks were made at Lockheed in the spirit of analyzing the role of PERT, not destroying it. The same people agreed that Lockheed has benefited from instituting the disciplined reporting system. The system has improved program planning to the point that they would continue to use it even if not compelled to. In this regard they say that the company now has better information available to its own management than ever before. But they are quick to point out also that the first Polaris was operational on time and PERT was not highly advanced at that time. This partly douses the notion that PERT was responsible for the Polaris delivery dates. One great modification in the program alone, changing from the concept of firing one missile from a submarine instead of the sixteen decided later, would have been enough to put PERT out of joint.

In Summary — The reporting aspect of PERT appears to have been the most beneficial at Sunnyvale. The three time estimate base of some PERT networks was widely criticized, starting from the fact that a critical path is determined from the estimate but this does not tell you in real time how critical is "critical." "This three time estimate is overly touted in that it is the customer who keeps the company committed to a real delivery date." One critic of three time estimates suggested that a "three budget estimate" would be a far better substitute. It was also suggested that the idea that the PERT system was the first to introduce network concepts in program planning is false since Dupont introduced them some years ago.

LINE OF BALANCE CHART



Management at Lockheed Sunnyvale uses this kind of Line Of Balance Chart for keeping track of and reporting on serial production of Polaris. PERT, as originally conceived, was useful only to serial number one.

One of Several—It should be noted that the Special Projects office of the Navy regards PERT as only one of several tools used in Polaris management. The other principal techniques are: Program Management Plans, Milestone Reporting, and Line of Balance. Historically, it has not been the function of the service customer to be a program manager with a forecast of program planning as its responsibility. Now the Department of Defense makes up its own mind on what is needed as a system to a far greater degree than ever before and in effect the services are acting as their own weapon system managers.

Program Management Plans technique was once reported to the Navy by Lockheed but the company is now no longer required to do so. The project Operations Manager does, however, conduct Polaris management meetings of the group shown in the organization chart. At these meetings, problem areas are shown in view chart form where only the exceptions to the expected are reported.

Line of Balance is used at Sunnyvale for reporting progress on serial production. PERT after all is only useful to the production of serial number one.

Milestone Reporting is not in use at Lockheed Missile Division since being cut out a year ago. It is considered that most of the milestones appear as events on the PERT charts with scheduled, expected and actual completion dates so that only one of the systems is needed.

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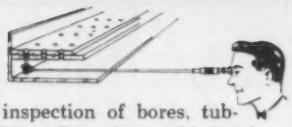

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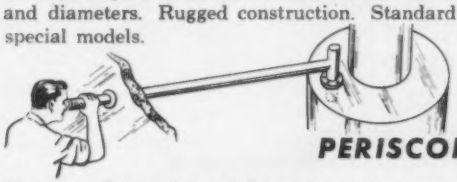

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Douglas Aircraft Company is part of the Army Ordnance-industry team developing the Nike Zeus Anti-missile System. Western Electric Company is the industrial prime contractor.

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Circle 18 on Inquiry Card

Quick Reaction Capability

Why You Need It . . . How To Get It . . .

- *Martin sets up "super-system" to speed priority electronics through production without losing quality or reliability.*
- *Short Order Shop is hub of entire operation — staffed by Manufacturing, Production Control, Quality Control, and Procurement experts.*
- *Entire procurement cycle runs on single piece of paperwork after initial work-order is issued.*

by Edwin V. Kapp,
Electronics Manufacturing Engineering
The Martin Company

More and more, DOD is using the Quick Reaction Capability concept (QRC) in letting contracts. Normal delivery times can be cut in half on this kind of contract. Priority electronic items have come in for the most heavy usage.

Even when contracts are not formally labelled "QRC," shorter-than-usual time limits are often imposed by defense needs.

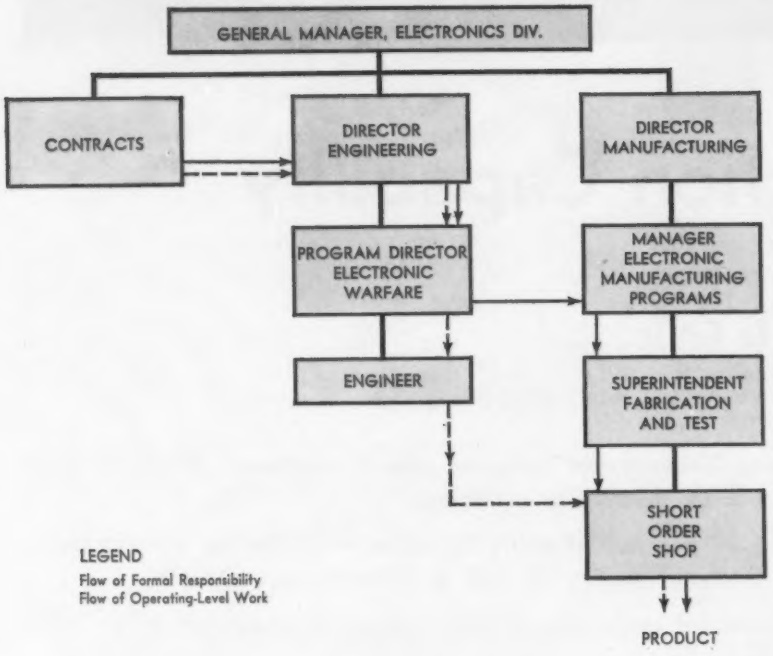
The Martin Co.'s Electronic Div., has been geared to meet such demands for more than a year. A kind of "super-shop" has been set up in the Manufacturing Dept. It is called the Short Order Shop. Experience shows it can produce small quantity orders within a tightly squeezed time-cycle—without relating quality control standards.

Martin's Kapp
don't compromise on reliability

SOS Action Team—Familiarly dubbed SOS, the Short Order Shop is run by a four-part team, of which Procurement, Production Control, Manufacturing, and Quality Control are the functions. All four groups are at work on a QRC item within one day of the release of a manufacturing directive placing a job in their shop. Action begins with receipt of the directive and the necessary minimum of engineering information—which may be nothing more than a rough pencil sketch. It ends with delivery of the finished product, accompanied by complete engineering drawings. Drawings make duplication of the product possible, facilitate later design changes, and afford necessary information for trouble-shooting and maintenance.

To carry production from beginning to end on an accelerated basis without loss of quality, the entire SOS has to be composed of highly skilled people exclusively. They have to be able to interpret engineering information with minimum documentation. Each individual has to be versatile and resourceful and be able to "grow on the job" in the face of changing requirements.

Areas of Responsibility—Within this streamlined activity, the Procurement group orders and expedites all purchased parts and materials; Production Control orders, delivers, and stocks parts and materials supplied inside the plant; Manufacturing arranges area facilities, gathers standard bin parts, and provides test equipment; and Quality Control coordinates with Receiving Inspection to insure rapid handling of purchased items, establishes test specifications, and per-



forms in-line and final inspection and test.

Responsibility for maintaining the close coordination required among this group belongs solely to the SOS General Foreman. Except for the Quality Control function, he controls the entire operation; this, of course, obviates the need for separate department heads in each group.

Engineer's Role in QRC—The duration of engineer's work depends upon the novelty and complexity of the customer's requirement. Generally speaking, it is unlikely that a fundamentally new type of equipment would be developed on a QRC basis; it is more likely that it would be either a modification of an existing piece of equipment, a recombination of established techniques, or a prototype for evaluation testing. In a typical case, the engineer might design a breadboard version of an equipment, which would then be evaluated for some time by the customer—who might then issue a QRC requirement. The design engineer prepares whatever is required in the shortest time possible for the Short Order Shop, and he works directly with the production control, procurement, manufacturing, and quality control people to expedite the job.

Throughout the job cycle, the project engineer works very closely with the SOS people, especially during the hectic period when last-minute changes and modifications are being made. During the progress of the job, he brings all of the required drawings up to date. The design never slips away from the rightful control of the engineer. A special advantage of his close integration with the SOS organization is that practical working modifications—to simplify manufacture, test, or both —can readily be introduced.

Operations Centralized — To save time, the four SOS groups have been physically centralized in a single plant-area. Even the parts crib is close at hand. While some specialized manufacturing functions — sheet metal shop and welding shop —are not represented in the SOS area, the same directive that specifies SOS treatment clears the way for first-priority handling anywhere in the Electronics Manufacturing Department. Required work is processed with a minimum of paperwork and special tooling.

An extremely important point in the ability to provide shorter-than-usual time cycles evolves around the operation of the SOS Procurement group. To expedite every required vendor-supplied item, this group of experienced buyers is permitted to buy directly from qualified vendors without having to proceed through the normal channels. For all practical purposes, this means that a phone call will route needed parts on their way by the fastest means available. For example, parts ordered by phone from New York City, shipped by bus, will be in the plant the following day. Or, parts bought in Chicago, air-expressed, will also be on hand in one day. In total, this often means the avoidance of a three to four-week delay as encountered while using normal channels.

Normal vs QRC Action—Normal (non-QRC) procurement procedures are standardized and formalized, to provide documentary control and to eliminate human error as far as practicable. In collaboration with Engineering, Production Control establishes all production requirements for a given job. The production requirement is set up on punched cards for information to all parties concerned; these cards also serve as permanent records for reorders and for cross-comparisons between contracts. Material Control uses the coded cards to check against inventory, establish procurement needs, and initiate purchase requirements. A purchase request is then issued to a buyer, who orders the item; in many instances he must obtain three bids before ordering. He may also have to establish vendor qualification before purchasing components. All items received are checked in through Incoming Inspection for

MODEL:
ORDER NO.
PT. AR. OR
DRWG. NO.
IDENT:

ELECTRONICS SHORT ORDER STATUS REPORT

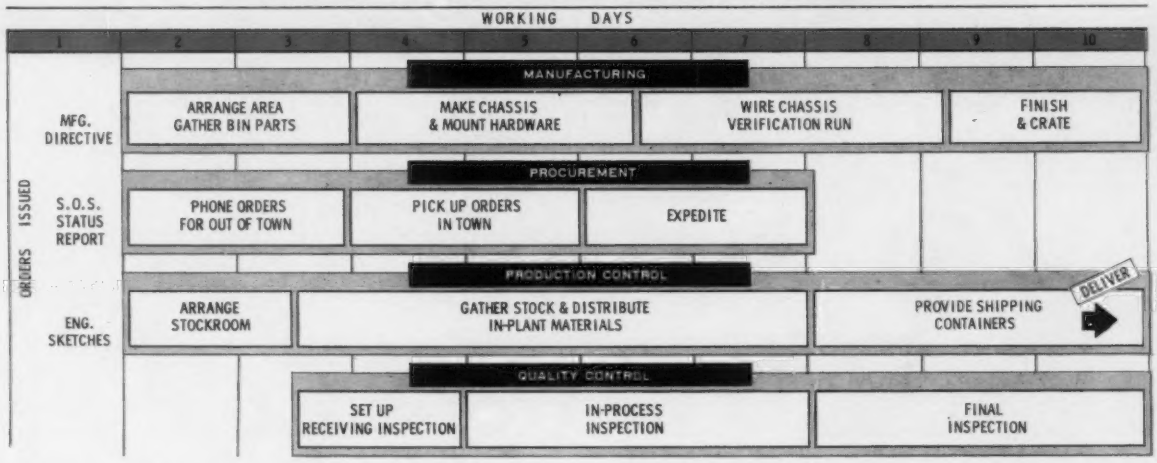
MAT'L. AVAIL.	PROC. AVAIL.	DETAILS & W/A COMP.	S/A AVAIL.	ASSY. COMP.	TEST COMP.

CLASS CODE
S-SHEET METAL
M-MACHINE SHOP
WD-WELDED DET.
WA-WELDED ASSY.
A-ASSEMBLY
SW-SPOTWELD
PA-PLUG ASSY.
CW-CUT WIRE
P-PROCUREMENT
X-OTHERS

QUALITY SPEC. COMPLIANCE

LINE NO.	P/M	CLASS CODE	PART NUMBER	DESCRIPTION	MATERIAL DESCRIPTION	QTY.	REMARKS	BUDGET ALLOCATE	PART INSP.

TYPICAL 10-DAY SOS WORK SCHEDULE



TOP—Single piece of paperwork is used to speed important orders through Martin's Short Order Shop. It is used by Procurement, Manufacturing and Quality Control.

CENTER—Work flow and schedule in Martin's "hurry-up" delivery service for electronic parts, shows functions of four major departments.

conformity to specifications. Transportation moves to work-stations as required.

In the Short Order Shop, however, Production Control works directly with the engineer to establish requirements and with Procurement to meet requirements, without elaborate documentation and inventory management problems. Parts are ordered by telephone for first-priority delivery, and go directly from Incoming Inspection to the point where they are needed.

Basic differences between normal and SOS procedure are twofold: (a) personal attention to detail needs of a single project; and (b) the by-passing of normal documentation. Neither of these would be feasible or economical normally on a plant-wide basis.

The Short Order Shop is not confined to working on product-line items: for example, a product being manufactured on a QRC contract may need a special piece of test equipment—which must also be produced on a hurry-up basis. To review cases of this sort, a permanent committee has been established within Electronics Manufacturing. It consists of the managers of Manufacturing Engineering, Special Projects, and Production Control. Upon reaching agreement, which usually takes very little time, they issue a manufacturing directive which initiates the SOS process as described.

Paperwork Reduced — An interesting sidelight to this process is the fact that so little paperwork is used. Aside from the initial manufacturing directive, the only form used is the Production Control SOS Status Report. This report is originated as soon as the directive is received, and becomes the key record of the job. Procurement uses it as the basis for buying; Production Control uses it for in-plant ordering; Manufacturing uses it as an in-process status report; and Quality Control uses it as a master log.

Basic philosophy in QRC Short Order Shop operations is: speed up production by reducing formal planning and record keeping—but don't compromise on quality or reliability.

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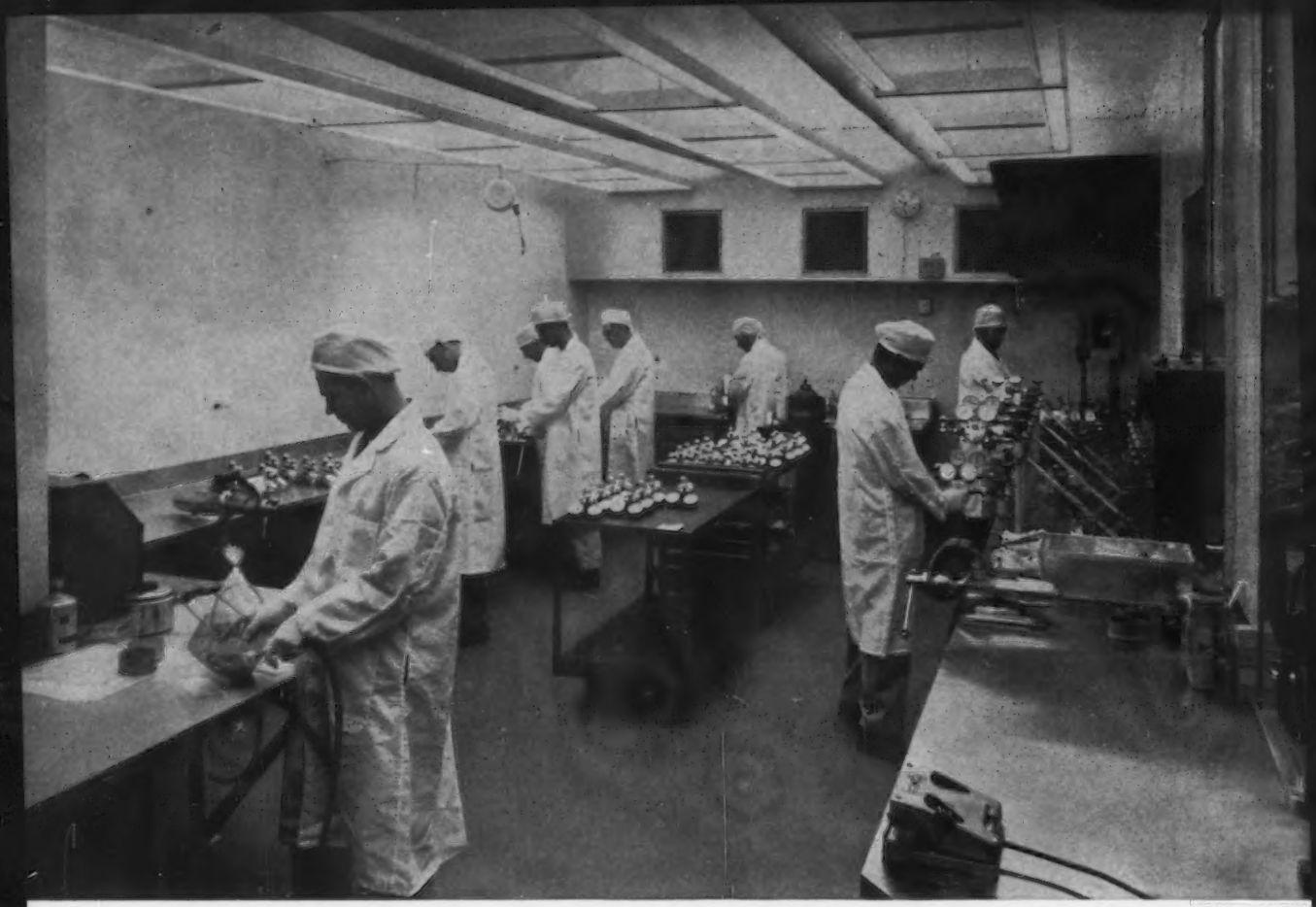

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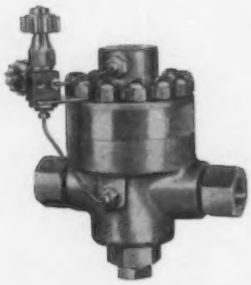

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REGULATORS

Bronze or stainless steel
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Outlet to 10,000 psig.
Flows to 10 scfm.
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40 inch lbs. at 7,000 psig.
60 inch lbs. at 10,000 psig.
Panel mounting.

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SPECIAL REPORT

Effectiveness of management is usually measured by return on investment, or percentage of profit on sales. The aerospace industry is no exception. This means that objectives must be pinpointed. It means that costs and profits must be accurately targeted. These are elusive goals in the aerospace industry, where technologies are constantly advancing and requirements are constantly changing. THIS REPORT, pages 47 to 62, gives some important tips on gearing your technical planning and marketing activities to meet with the procurement patterns of Air Force, Navy, Army, and the major weapon system managers.

MARKSMANSHIP IN MANAGEMENT

Profits—

Why DOD Pays Them . . . How You Can Increase Yours

- *In every type of DOD procurement contract, the profit motive is used as an incentive for industry to cut cost.*
- *In fiscal '62 greater emphasis will be put on higher profits for those willing to take more risk.*
- *Here is what DOD will be looking for.*

by John P. Kushnerick

At last count, the many-times-revised defense budget stood at $46.6 billion.

Anxiety over Berlin caused the Congress to speed through the latest revision. The new funding gives Air Force $18.9 billion, Navy $14.5 billion, and Army $11.8 billion.

How will all this money be spent? With over $16 billion of it, the services will buy the best aerospace hardware that industry can produce.

The Profit Motive—The national interest, the challenge and glamour of pioneering new technologies, and the profit motive will lure about 5000 firms, big and small, to compete for these dollars.

It is no secret that the profit motive plays a big part in drawing some of the nation's biggest companies, best brains, and finest equipment into the aerospace industry. The profit motive has been one of the main sources of strength in the industry.

In recent times, however, profits have come in for close scrutiny, and heavy criticism. But most of the experts feel that if the profit motive dies, the competition it breeds will also die. Without competition progress will come slower and costlier, they say.

Industry can show "proof" that it is making too little profit from government contracts. The Department of Defense (DOD), on the other hand, is sure that the sum total of costs for the things it buys is too great. From the buyers' viewpoint, profit is always an ingredient of cost. DOD does not want both profits and costs to be high. It is trying to find ways to reward cost cutting with higher profits.

Now how does the profit motive come into play in present types of defense procurement contracts?

How does DOD try to keep the profit motive alive while keeping profits in check?

What kind of contractor action does DOD intend to reward with higher profits?

What incentives is DOD offering for industry to cut costs?

Can you increase your profits in FY62?

As an engineer and manager, you should have answers to these questions.

Fixed Price vs. Fixed Fee—Theoretically, the firm-fixed-price (FFP) contract offers industry the maximum profit incentive. The price of the contract is based on cost of production plus profit. Every

dollar shaved from the cost of production goes to the contractor. With such obvious profit motivation the utmost in cost reduction would be expected.

It would also be expected that this is the kind of contract industry would seek. But the facts are that in the past fiscal year less than one third of DOD procurement dollars were placed on the straight fixed-price contract.

This has been the trend since 1951. There has been a steady decline in fixed-price contracts, where the contractor assumes the major risk. Another kind of contract, the cost-plus-fixed-fee, (CPFF) has come into dominance. This kind of contract represented on 13 per cent of the total defense procurement in 1951. Today it represents over 42 per cent.

Part of the reason for this is that the FFP contract is too great a risk. There are too many uncertainties in pricing complex aerospace projects that constantly tax the state-of-the-art. Industry wants the chance to make more profit, but there is a limit on the risk it can logically take.

Incentives For What? Now, if industry doesn't like the FFP contract and government doesn't like the CPFF contract, the door is immediately open for a host of compromises.

In fiscal 1960, only $672 million in contracts was awarded under an arrangement known as the cost-plus-incentive-fee (CPIF). DOD would like to see industry request and accept more incentive type contracts. Contracting officers will be giving new attention to employing incentives in FY62. Contractors who understand this kind of arrangement and show a willingness to accept it will have an advantage over firms that insist on CPFF.

Profit motivation in the incentive contracts is simple. Government and industry negotiate a "target" cost. They also negotiate a "target" profit. A formula is worked out for industry to get a greater profit to the extent that costs are kept below target. If they climb above target, there is a similar formula for government to pay less profit.

Incentives Fall Short—This form of contract should produce a greater incentive to reduce costs than it usually does.

In the first place, contracts of this sort normally are placed without really effective price competition. To the extent that the contractor is able to inflate his costs estimates and produce an unrealistic cost target, to that extent he begins his operation with a cushion. A drive to reduce costs in a cushion situation, known to management, naturally is less compulsive than one in which the estimate is known to be tight.

The second diminution on urge to reduce costs in a fixed price incentive contract is the fact that the contractor converts to profit only a portion of what he saves on costs, or vice versa. The balance goes to or comes from the Government. Sharing of risk or reward never produces the same urgency as when one carries all the chips in his own hands.

What DOD Is Doing—Government realizes the weaknesses that exist in present incentive type of contracts. And it has set several objectives for itself to make this kind of contract more inviting and more effective. The objectives are:

(1) Perfect DOD techniques and procedures for using incentives and measuring results achieved.

(2) Spread the range of possible profits on incentive contracts.

(3) Perfect an incentive contract that can be used for development and early production work.

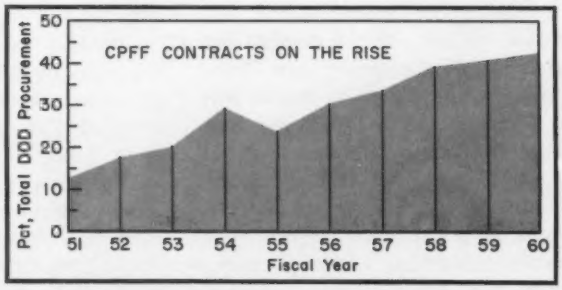
What DOD Will Look For—In targeting the first objective, DOD will put more emphasis on price analysis. Costs will be examined in sufficient depth and detail to test their accuracy.

Ability to differentiate between good and bad work will also be sharpened. There are several things DOD will have its eye on in seeking out and rewarding contractors:

(1) History in meeting schedules.
(2) Quality and reliability of product.
(3) Securing competition in purchasing.
(4) Emphasis on value engineering.
(5) Past performance on contracts.

Cost Conscious Attitude—There are other factors which, while not intangible, are less susceptible of objective measurement. They can be summed up as an attitude. And they will carry a good share of

Asst. Sec. Det Morris ". . . over the long run, a company's incentive to earn more is the keystone of its effort to produce better products at lower cost . . . (we) need to expand incentive contracting in our programs . . ."



weight in deciding incentive awards. The attitude is one of cost consciousness—an effort to save dimes as well as thousands of dollars.

This is how Asst. Sec. Def. for Installations and Logistics, Thomass D. Morris describes this attitude: "While not subject to measurement, an attitude toward cost consciousness is easy to sense when it exists —and its absence is manifested in dozens of ways in the day-to-day decisions which are required."

Wider Profit Range—The second major DOD objective is to provide a wider range of profits in incentive contracts. The normal spread on CPIF contracts is now running from a minimum of 4.5 to 5 per cent up to a maximum of 8.5 to 9 per cent. The target is 6.5 to 7 per cent. In fixed price incentives DOD seems married to a 80 to 20 per cent or a 75 to 25 per cent sharing setup with industry.

Sec. Morris would like to use the full statutory range of allowable profits on CPIF contracts. These run from 0 to 15 per cent.

He would carry the same philosophy into FPI contracts. He envisions instances where a 50-50 sharing formula would be used. "Such spreads," he says, "in the ranges of allowable fees and profits impose greater responsibility and greater risks, but they also offer the promise of greater rewards. . . . I am willing to accept the responsibilities and encourage these risks."

Incentives in R&D—DOD's idea for an incentive contract that would be used in development or early production work is a "cost-plus-award-fee" arrangement. After agreeing on target costs and defining the areas of risk, the range of fees would be set. The range might be from as low as minus 5 per cent to plus 15 per cent of the then-estimated cost. The exact amount would be determined after the contract completion. There would be no pre-set formula. The award fee might be determined by a board of qualified "judges." The Secretary concerned would select the judges from a body of respected professional people.

After completion of the contract, this Board would judge the overall performance of the contractor and set the fee. This would entail assessments of efficiency; economy; ingenuity; changes in contractual requirements; assumption of technical, production, and financial risks; break throughs achieved; amount of government assistance required, etc.

That is one idea. DOD is exploring others. For, there is a strong desire to have development work done on incentive contracts.

Performance Incentives—Another means of providing an incentive for a contractor to do a better job is the contract which increases profit to the extent that the end item surpasses its performance goals. There are also provisions for decreased fees if the end item fails to achieve the desired performance. While there is a profit motivation for surpassed goals in this type of contract, there is still an agreed to profit for minimum performance of the end item.

Value Engineering Clause—Finally, profit motivation is being stimulated by the inclusion of a value engineering provision in DOD contracts. The profit motive encourages a contractor to devote time and effort to value engineering studies to reduce costs.

Realistic Targets—The key ingredient in all incentive contracts is realistic target cost.

If Government foolishly insists on targets that are too low, over runs and funding problems are certain.

If the contractor talks the Government into targets that are too high, increased profits are paid out not for cost reductions, but for lack of negotiating skill by the Government.

Profit Motive In CPFF?—Now how about the Cost-Plus-Fixed-Fee (CPFF) contract. Over $9 billion of procurement was let under this arrangement in 1960. CPFF is part of the missile age and the concept of concurrency. There is nothing on the horizon which will replace it in the near future.

Critics of this kind of contract say there is no profit motivation in it.

In a CPFF contract, the contractor is reimbursed all his allowable costs and is paid a fixed sum as a fee. The fee is based on the estimated costs of performing the contract.

In an economy like our own, the effectiveness of management is usually measured by the return on investment, or the percentage of profit on sales.

In a CPFF contract the incentive to management is to reduce costs to the minimum so that the fixed fee represents the highest possible percentage of profit with relation to the costs or sales volume.

For example, assume that the estimated cost of performing a CPFF contract was $1,000,000, with a fixed-fee $50,000 having been negotiated. If the contract is performed for the estimated cost figure, the contractor will realize a 5 per cent profit. However, as the actual allowable cost varies from the estimate, the profit percentage in relation to the cost varies (although the contractor receives the same dollar amount as a fee, i. e., $50,000). If the reimbursable costs can be reduced to $900,000 the profit percentage on costs will rise to 5.55 per cent. Conversely, if the reimbursable costs go up to $1,100,000 the profit percentage scoping or extending time enters into this also, because capital turnover is affected.

Management, which must report to the business owners, has a definite motive for striving for a reduction in costs on a CPFF contract.

This article based on facts supplied by DOD Comptrollers Office, talks before the Joint Industry-DOD Conference sponsored by NSIA, and the defense budget for fiscal 1962.

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Navy Procurement Planning

The Deputy Chief of the Bureau of Naval Weapons, RADM Schoech tells firms interested in doing business with Navy:

- *How Navy evaluates weapons systems proposals*
- *What considerations influence procurement planning*
- *How contractors can help Navy and themselves reach procurement objectives*

Navy's procurement planning pivots on four basic factors:

- National policies
- Intelligence estimates
- Economic status of our country
- Future needs based on the roles and missions of the Navy

These factors are synthesized in the Office of the Chief of Naval Operations, then are spelled out as material requirements. If they survive our budget processes these requirements are levelled on the technical bureaus of the Navy for procurement purposes.

Here are the basic questions the Navy asks to evaluate Weapon Systems Proposals; this evaluation influences the final procurement plans:

(A) Requirement

- Is there really a hard requirement for the weapon system and do we have a sound operational concept for its use?
- Is the requirement supported by sound intelligence estimates?
- Are we quite sure that a better system will not be available during the time period?
- Are we quite sure that another system as good, or almost as good, is not already in the mill?
- Are we sure that it will be compatible with other systems with which it must operate?

(B) Feasibility

- Is the proposed system within the state-of-the-art and technically feasible?
- Is the proposed system operationally feasible? Can it be operated with a high availability rate by average officers and men and with normal operation of Murphy's law?

(C) Economics

- Is the cost commensurate with the urgency of the requirement?
- Can we expect that the necessary funds will be available for both R&D and production during the time period involved?

The Department of Defense is actively engaged in identifying outmoded or incomplete procurement methods. Streamlining of outmoded procedures with outright elimination of some will be the order of the day. Revisions are to be made to afford quick reaction to constantly-changing circumstances. While we desire to simplify and streamline our overall procurement operations, we cannot attain our goals without the contractors' objective interest and cooperation.

In this connection the Aerospace Industries Association recently sent a letter to the Secretary of Defense. This letter presented AIA's views on what the Government could do to improve our procurement policies and procedures. While it is too early to appraise the results of these suggestions, the fact that they were made is most encouraging.

We have all seen what competition can do to meet our requirements objective and achieve "close pricing" for those products where circumstances permit competitive procurement. Complex weapon systems generally do not lend themselves to strict price competition. However, complementary parts of many major systems lend themselves to competition either through breakout of components for direct purchase or by the prime contractor searching out competition for components, sub-components or sub-systems. Timely and thorough advance planning is the key to increased competition in these areas without jeopardizing delivery schedules or quality of the end weapon.

Now, what are we doing to improve in this area? In the bureau of

RADM William A. Schoech

. . . Continued threat to our national security will require cooperation between Government and industry to an extent never known before.

FLOW CHART — TYPICAL PROCUREMENT WITHIN THE DEPARTMENT OF THE NAVY

STEPS	DESCRIPTION	JCS/ FLEET	CNO	BUREAU	ONM	ASN(M)	INDUSTRY	FIELD INSP & AUDIT
1	GENERATES BROAD REQUIREMENTS	1						
2	PREPARES OPERATIONAL REQUIREMENTS		2					
3	PREPARES PROCUREMENT REQUEST, DETERMINES METHOD OF PLACEMENT AND SOURCES TO BE SOLICITED, PREPARES REQUEST FOR AUTHORITY TO NEGOTIATE (RAN) AND DETERMINATION AND FINDINGS (D&F)			3				
4	REVIEWS AND APPROVES RAN AND D&F				4			
5	APPROVES AND SIGNS D&F					5		
6	REQUESTS PROPOSALS FROM INDUSTRY			6				
7	PREPARES AND SUBMITS PROPOSALS						7	
8	BUREAU EVALUATES PROPOSALS, PREPARES PRENEGOTIATION CLEARANCE			8				
9	REVIEWS AND APPROVES NEGOTIATION PLAN				9			
10	SURVEYS SUPPLIER PRODUCTION, FINANCIAL AND TECHNICAL ABILITY AS NECESSARY						10	
11	VERIFIES SUPPLIER FINANCIAL ABILITY AND ANALYZES COSTS. NEGOTIATES PRICE AND TERMS WITH PROPOSED CONTRACTOR. PREPARES BUSINESS CLEARANCE			11			11	
12	REVIEWS AND APPROVES BUSINESS CLEARANCE				12			
13	PREPARES CONTRACT. COUNSEL FOR FORM AND LEGALITY. COMPTROLLER REVIEWS FOR ADEQUACY OF FUNDS AND ACCOUNTING DATA			13				
14	CONTRACTING OFFICER AND SUPPLIER EXECUTE CONTRACT			14			14	

Powerful influence of the Bureau of Naval Weapons is evident from number of stops procurement proposals make there.

naval weapons, and in other major segments of DOD as well, we start procurement planning at the same time we include a proposed item in a budgetary request. This planning includes: how the selection of the design agent will be made; extent to which competition for the end-item among small and large businesses alike may be introduced at the earliest time; or, lacking practicability of competition for the whole system, then for portions of the end item including replenishment or maintenance parts. This process involves many considerations among which are:

Determination of Data Requirements — We will identify our requirements and will insist on our rights to secure data for competitive procurement where competition is later practicable.

Management of Data—We must assure that we will not buy and burden our system with useless or unmanageable masses of data. In addition, we must assure that the data we get is current, readily available, and usable when needed. To this end, contractors who are design control agents may find increasing use of contractual provisions which will require, in their design and development contracts, their agreement to submit up-to-date data packages when we require them. Of course, we'll pay the reasonable cost of preparation of these data and respect proprietary rights.

"Break Out" — We will determine early those items which can logically be "broken out" from the system for competitive procurement.

Spare-Parts Procurement — We will continually review our requirements and plan for competitive procurement or for purchase direct from qualified suppliers when such is practicable and economical.

These are but a few examples of what we will do. Little will be accomplished, however, without contractors' cooperation and support.

Contractors Can Help — They can assist by:

- Responding promptly and fully to contractual commitments for delivery of data.
- Exercising greater control over design or product improvement changes so that only those which offer decided improvements in quality, reliability or economy are made.
- Offering greater opportunities for competition at their suppliers' level.
- Calling our attention to areas of over-specification where performance of end-item will not be prejudiced appreciably by use of less-expensive components or methods of production.
- Calling our attention to our own errors of either commission or omission which cause the incurrence of allowable but avoidable costs.

Our country cannot afford the present rate of increasing national defense costs for an indefinite time. It is likely, however, that the threat to our national security will continue indefinitely. It follows, therefore, that we must design and produce our weapons with a degree of emphasis on economy that we have never known before. This will take, on the part of both industry and Government, an extent of soul-searching and mutual cooperation that we also have never known before.

This article is based on presentation made during Michigan Aeronautical and Space Assn. meeting held this summer in Detroit.

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AF Centralizes Management

- *Formation of Air Force Systems Command (AFSC) integrates responsibilities for: Research—Development—Production—Procurement*
- *Here's a breakdown of functions assigned to AFSC divisions.*

The new-born Air Force Systems Command (AFSC) was conceived by the urgency for improved systems management. AFSC is designed to meet the aerospace challenges of the future through: (1) Straight forward realignment of functions and responsibilities; (2) redistribution of associated resources. It centralizes management for research, development, production, and procurement. Air Force feelings behind this move are crystallized by Gen. Schriever's statement . . . "In the development of long-range ballistic missiles, the Air Force found that management was the key to success."

In essence, AFSC aims are to:

- Provide fast decisions and actions for weapon-system programs.
- Insure efficient, responsive management of Space Development responsibilities recently assigned to Air Force.
- Provide for the close integration and participation of the Army Corps of Engineers in missile site activation task.
- Promote effective liaison and active participation by Army, Navy, and NASA on projects being developed for those agencies by Air Force.

From headquarters at Andrews Air Force Base, Md., AFSC's commander, Gen. B. A. Schriever, directs its far-flung operations. Deputy Commander, AFSC for Aerospace Systems, is Lt. Gen. Howell M. Estes, Jr. His office is located near Los Angeles. Under the Operational control of the Deputy Commander come the Ballistic Systems Division and the Space Systems Division.

Deputy Commander's Office provides on-the-spot decisions for the space development mission and priority ballistic missile systems. It also insures effective liaison with the Army, Navy, and NASA.

Liaison with the Air Force Logistics Command, the Air Training Command and the using commands is also maintained to insure optimum coordination and planning for operational systems.

Space Systems Division (SSD)—Located near Los Angeles this division is responsible for military space programs assigned to the USAF, and for certain development projects in support of the Army, Navy and NASA. Resident representatives of the Army and NASA are co-located with SSD to provide daily participation in their development programs.

The 6565th Test Wing (Development) and the 6594th Test Wing (Satellite) are assigned to SSD.

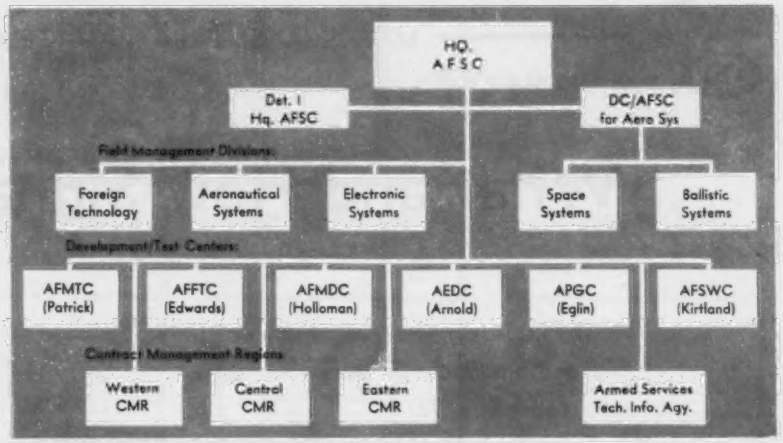
Ballistic Systems Division (BSD)—This division has available all the management resources required for the development, test, evaluation, procurement, production, site activation and planning for the support and operation of ballistic missiles.

The division, located in Los Angeles area, is responsible for the Atlas, Titan, and Minutemen international ballistic missile programs. The 6555th Test Wing (Development) is assigned to BSD.

Deputy Commander of the Ballistic Systems Division is in charge of facility design, construction, installation, and checkout. By agreement with the Department of the Army, operational control of the U. S. Army Corps of Engineers Ballistic Missile Construction Office with its subordinate units is assigned to BSD.

Aeronautical Systems Division (ASD)—This division is located at Wright-Patterson AFB, Dayton, Ohio. It is responsible for planning, programming, and managing the development of aerospace systems assigned by headquarters AFSC. ASD is concerned with such programs as the new C-141 jet transport, Skybolt and Dyna-Soar.

Electronic Systems Division (ESD)—L. G. Hanscom Field, Bedford, Mass., is the headquarters of ESD. Responsibilities of this division include planning, programming and managing the development of command and control systems. ESD is also responsible for other electronic developments necessary to permit exercise of weapon, com-



Gen. Bernard A. Schriever . . . in development of long-range missiles

. . . management is key to success.

mand and executive control associated with aerospace operations.

The Rome Air Development Center, located in Rome, N. Y., is a subordinate unit of ESD.

Foreign Technology Division (FTD)—Headquarters of FTD is at Wright-Patterson AFB, Dayton, Ohio. This division has the responsibility of technical management for the acquisition, production, and distribution of Foreign Technology throughout the command as well as to other elements of the USAF and DOD.

AFSC CENTERS — Air Force Systems Command centers support the missions of the five divisions on the basis of their capability and role in attaining AFSC aerospace objectives. The centers function in the following specific areas:

● Air Force Missile Test Center (AFMTC), Patrick AFB, Florida, maintains and operates the Atlantic Missile Range (including Cape Canaveral Missile Test Annex) in support of U. S. Missile and space programs.

● Air Force Flight Test Center (AFFTC), Edwards AFB, Cal., conducts Aircraft Category II Tests; evaluates captive missile systems and subsystems; and conducts flight evaluation of designated research vehicles. (Category II Test is a final functional test and military demonstration of a complete system to determine whether it is capable and suitable of meeting the established requirements and design objectives. This is a joint contractor-Air Force effort.)

AFFTC is the home of the X-15 and the Air Force Test Pilot School.

● Air Force Special Weapons Center (AFSWC), Kirtland AFB, New Mexico, provides engineering support and testing in the field of nuclear energy. This includes nuclear weapon systems, nuclear power applications and associated phenomena and environment.

Research responsibilities include: studies of the vulnerability of nuclear warheads and nuclear power sources, protective construction design criteria, radiation hazards, protective measures, and human engineering requirements associated with nuclear weapons and the operation of nuclear systems.

● Arnold Engineering Development Center (AEDC), Tullahoma, Tenn., provides test support in gas dynamics and propulsion, using ground facilities to simulate flight conditions. Arnold is the wind tunnel center of the U. S. Air Force.

Twenty-one of the nation's 25 top-priority space and weapon systems have been tested at AEDC.

● Air Force Missile Development Center (AFMDC) is located at Holloman AFB, New Mexico. From the headquarters and laboratories at Holloman and the White Sands Missile Range, the research and development testing of guided missile weapon systems is directed.

This center supports the exploration of the extreme reaches of Earth's atmosphere and beyond by rockets, balloons and instrumentation. Research related to the hazards and other problems of human flight through interplanetary space is conducted at the center.

● Air Proving Ground Center (APGC), Eglin AFB, Florida, carries out research and development in: electronics, atmospheric and space-probe projects, the testing of air-to-surface and surface-to-air missiles, and the integration of complete weapon systems.

APGC also computes and maintains Air Force ballistic tables; develops, tests, operates and maintains drones; operates the Climatic Laboratory; does research in bioastronautics; and manages the Eglin Gulf Test Range.

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Systems staff personnel in Deputy Chief of Staff, Systems & Logistics Office, Pentagon.

SYSTEM	OFFICER	PHONE
Minuteman	Col. R. E. Barnes	OX-7-3481
Atlas	Lt. Col. R. E. Seccomb, actg.	OX-7-7681
Titan	Col. F. S. Porter, Jr.	OX-7-9926
B-70	Col. A. S. Low, Jr.	OX-5-4901
Midas	Col. J. J. Pelligrini	OX-7-1791
Saint	Major W. D. Baxter	OX-7-8384
Boosters	Col. H. W. Gainer	OX-7-5989
Dyna Soar	Col. B. H. Ferer	OX-5-6234
GAM-87	Col. J. H. Hobaugh	OX-5-6235
Discoverer	Maj. M. L. Erwin	OX-7-8527

What and How Signal Corps Buys

A 250,000-item shopping list awaits big and small contractors who know how to:

- *Find out what is needed*
- *Introduce new products*
- *Get on Bidders' Lists*
- *Submit good proposals*

Brig. Gen. Charles S. Hays

by S. Peter Kaprielyan

Since President Kennedy issued his directive calling for a 10 per cent increase in military contract awards to small business firms, a lot has happened. And it has happened fast.

The U. S. Army Signal Supply Agency (USASSA) is one branch of the military that has seized the initiative. Specifically, they have sponsored three Small Business Conferences. Locales of the conferences were: Philadelphia, Chicago, and Pasadena. The prime purpose of each was to advise small firms how to do more business with the Signal Corps, and other military agencies.

The need for urgent action was revealed by some statistics on military procurement quoted by John E. Horne, Administrator of the Small Business Administration (SBA):

- Small-business' share of all military contracts has declined steadily. This decline has been from 25.3 per cent in FY 1954 to 16.1 in FY 1960.
- During the first nine months of FY 1961 the decline has been still further to 15.4 per cent. This compares to 15.7 per cent in the same period of FY 1960.

DOD reports blame this drop on an increased demand for military hard goods which small firms find difficult if not impossible to produce.

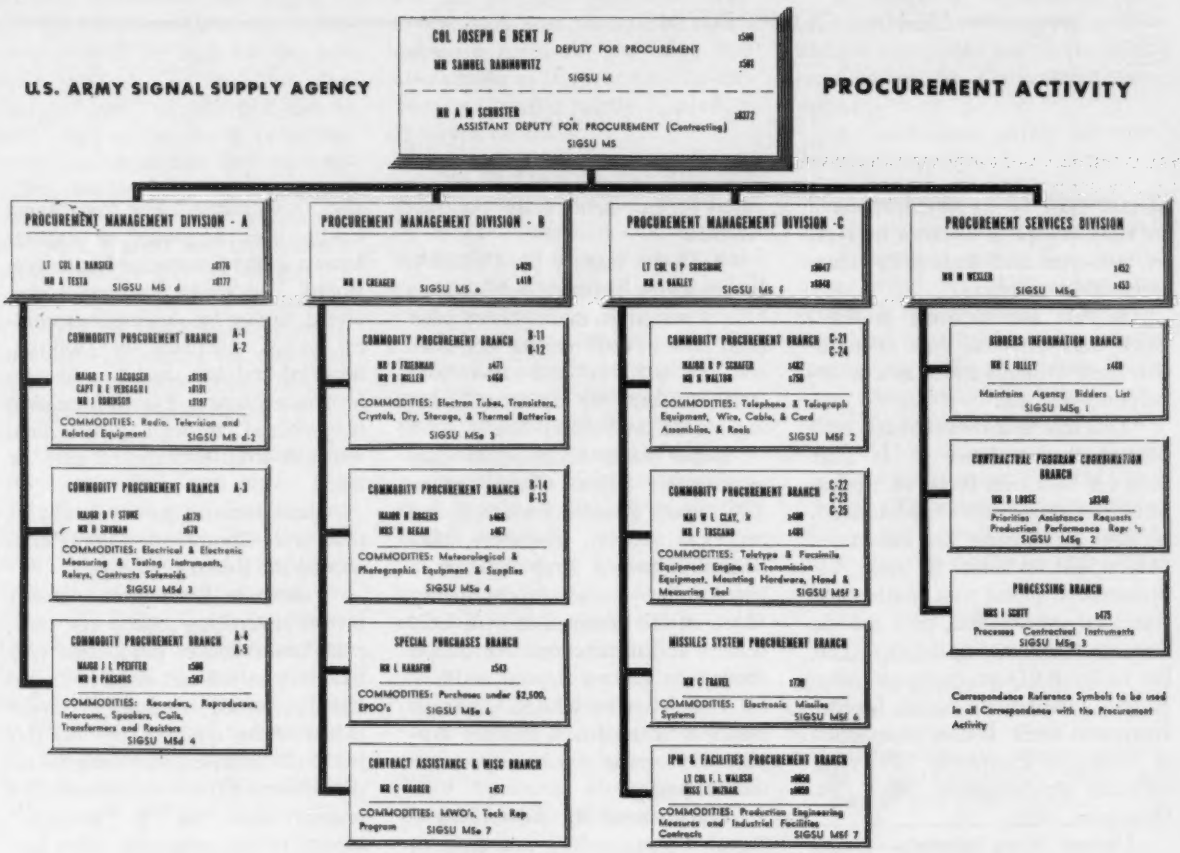
Inequities Charged — Administrator Horne says that the DOD statement is only partly true. He further states that inequities have been allowed to develop under the "weapon-system concept" of government procurement. He adds that less than 4 per cent government funds for R&D go with the small businesses. He claims this creates a monopoly of "know-how." This, he says, "helps to create and perpetuate a monopoly in productive capacity and contract letting."

Helping Small Business — But, the USASSA wants to help small Business. It wants small business to know what is bought in the Signal Corps and how it is bought.

The mission of USASSA is global. The agency supplies communications electronics equipments to: Army, Navy, Air Force, and over 90 member countries in Mutual Security Program. It has integrated responsibilities for both supply control and procurement.

In carrying out its mission under Brig. Gen. Charles S. Hays, the Agency is the National Inventory Control Point for 250,000 different items. Its major interests are: avionics, electronic countermeasurers, data processing systems, infrared ultraviolet meteorological instruments, radar, radio and wire communications, and sound, light and television equipment.

USASSA, with headquarters in Philadelphia, has five regional offices: Pasadena, Cal.; Chicago; Ft. Monmouth, N. J.; Ft. Huachuca, Ariz.; and Washington, D. C. In FY 1960 55,000 contracts were awarded, valued about one-half billion dollars. Of this dollar value, Small Business received 13.7 per


U.S. ARMY SIGNAL SUPPLY AGENCY
PROCUREMENT ACTIVITY
COL JOSEPH G BENT Jr
DEPUTY FOR PROCUREMENT
SIGSU M
MR SAMUEL BABINOWITZ
MR A M SCHUSTER
ASSISTANT DEPUTY FOR PROCUREMENT (Contracting)
SIGSU MS
PROCUREMENT MANAGEMENT DIVISION - A
PROCUREMENT MANAGEMENT DIVISION - B
PROCUREMENT MANAGEMENT DIVISION -C
PROCUREMENT SERVICES DIVISION
COMMODITY PROCUREMENT BRANCH A-1 A-2
COMMODITIES: Radio, Television and Related Equipment
SIGSU MS d-2
COMMODITY PROCUREMENT BRANCH A-3
COMMODITIES: Electrical & Electronic Measuring & Testing Instruments, Relays, Contracts Solenoids
SIGSU MSd 3
COMMODITY PROCUREMENT BRANCH A-4 A-5
COMMODITIES: Recorders, Reproducers, Intercoms, Speakers, Coils, Transformers and Resistors
SIGSU MSd 4
COMMODITY PROCUREMENT BRANCH B-11 B-12
COMMODITIES: Electron Tubes, Transistors, Crystals, Dry, Storage, & Thermal Batteries
SIGSU MSe 3
COMMODITY PROCUREMENT BRANCH B-14 B-13
COMMODITIES: Meteorological & Photographic Equipment & Supplies
SIGSU MSe 4
SPECIAL PURCHASES BRANCH
COMMODITIES: Purchases under $2,500, EPDO's
SIGSU MSe 6
CONTRACT ASSISTANCE & MISC BRANCH
COMMODITIES: MWO's, Tech Rep Program
SIGSU MSe 7
COMMODITY PROCUREMENT BRANCH C-21 C-24
COMMODITIES: Telephone & Telegraph Equipment, Wire, Cable, & Cord Assemblies, & Rods
SIGSU MSf 2
COMMODITY PROCUREMENT BRANCH C-22 C-23 C-25
COMMODITIES: Teletype & Facsimile Equipment Engine & Transmission Equipment, Mounting Hardware, Hand & Measuring Tool
SIGSU MSf 3
MISSILES SYSTEM PROCUREMENT BRANCH
COMMODITIES: Electronic Missiles Systems
SIGSU MSf 6
IPM & FACILITIES PROCUREMENT BRANCH
COMMODITIES: Production Engineering Measures and Industrial Facilities Contracts
SIGSU MSf 7
BIDDERS INFORMATION BRANCH
Maintains Agency Bidders List
SIGSU MSq 1
CONTRACTUAL PROGRAM COORDINATION BRANCH
Priorities Assistance Requests Production Performance Repr 's
SIGSU MSq 2
PROCESSING BRANCH
Processes Contractual Instruments
SIGSU MSq 3
Correspondence Reference Symbols to be used in all Correspondence with the Procurement Activity

cent. Production contracts awarded by Headquarters in Philadelphia for FY 1960 reached $170 million. Some $200 million are awarded in R&D contracts by USASSA annually.

Introducing New Products — If you have a new R&D concept or a new product which you would like to introduce to Signal Corps, contact: J. F. Mannix, Industrial Liaison Officer, U. S. Army Signal Research and Development Laboratories, Ft. Monmouth, N. J. Contact may be made either by letter or personally. If your idea is considered of interest, arrangement will be made for a presentation to the engineering office directly concerned. If your idea or product fills a need, the Request For Proposal may be issued to you only. However, the procurement would still be subject to publicity under the synopsis procedure.

Finding What Is Needed — To find out what the Signal Corps needs in research and development, the above Industrial Liaison Officer may be contacted. He is in a position to point out problem areas and explain the conditions under which you may participate.

Synopsis Method — Office of Field Services, Department of Commerce publishes daily a "Synopsis of U. S. Government Proposed Procurement, Sales and Contract Awards." This publication contains abstracts of all Signal Corps R&D procurements; however, it excludes classified items, and those limited to educational institutions. A third type of excluded item involves procurements of an urgent nature, having a short solicitation time.

The synopsis is available on subscription; it is also posted on all Army Procurement Office bid boards. The Ft. Monmouth Office maintains bid boards with invitations to bid from all Signal Corps procurement offices.

Getting on R&D Bidders' List —Principal Signal Corps Bidders' List for R&D is kept at Ft. Monmouth Procurement Office. Point of contact there is Charles Hoyt, Small Business Specialist. Initial letter should indicate the interest to be placed on Ft. Monmouth Procurement Office Bidders' List. It should also outline the areas of interest, and past accomplishments in R&D work. The needed forms and filling instructions are furnished, upon request, by Procurement Office. A personal visit is better for a detailed discussion of the following aspects:

- Prospective contractor's engineering facilities: electronic lab equipment, engineering and scientific personnel and their backgrounds.
- Production potential: plant size, layout, available labor market conditions, major fabrication equipment, environmental test facilities, previous production experience, and plant-security measures.
- Financial ability to perform: recent balance sheets, profit and loss statements. Contractor's accounting

system must be in sufficient detail to alloy complete analysis of costs in cost-type and fixed-price redeterminable contracts.

- Past achievements in R&D work, and statistical data to establish small-business status in a labor-surplus area, etc.

This information is entered on a field-of-interest form; it is later used for soliciting firms with capabilities in each field. Ft. Monmouth is now developing an automated bidders'-list system. It uses Addressograph plates with routine and statistical information, plus specific data on technical capabilities. This list is for R&D procurement only. A less comprehensive list for development work is also maintained at Army's Electronic Proving Grounds Procurement Office, Ft. Huachuca, Ariz.

Update Your Interests—Signal Corps advises bidders very strongly to keep their field-of-interest information up to date. This insures receipt of invitations to bid on the basis of current capabilities.

It is not necessary for a firm to be on existing bidders' list, to bid on a current procurement. A company not previously on bidders' list, upon request, may receive bid papers from the procurement office involved. Together with the bid papers, forms are also sent to the company for getting on future bidders' list.

Production Bids—Industry can get on Signal Corps production bidders' list by the following methods.

- Contractor visits to USASSA to discuss fields of interest. Appointments are not necessary.
- By a letter expressing a desire to be added to bidders' list.
- Through referrals from other services or departments.
- Through contractor requests for specific bid—sets announced in Synopsis of U. S. Government Proposed Procurement, Sales Contract Awards.
- Direct inquiry by USASSA. By reviewing industry publications, bills of materials, maintenance parts lists, and advertisements USASSA contacts industry and asks contractors if they are interested in being placed on bidders' list.

Depot Lists—Contractors may also supply Signal Corps depots. The depots procure for stock and for local support. Therefore, they normally have a large volume of low - dollar - value procurements. Much of this business is with local dealers and distributors. All that is needed to get on depots' bidders' list is a letter to USASSA's Small Business Specialist. A Bidders' Application form is sent in response to such inquiries.

Procurement By Advertising—Signal Corps prefers procurement by formal advertising. But, there are conditions when this method does not meet the needs of the Government. Typical of these conditions are: urgency of the need, R&D nature of item, the interest of national defense or industrial mobilization, lack of procurement data, etc.

In such cases, negotiation is used. This however, does not preclude competition. Hence, even when only one source of supply exists, the procurement is synopsized to encourage other qualified sources to bid.

Small purchases not exceeding $2500 can also be negotiated. When value of award is under $250, it may be made without competition. However, when there is more than one qualified source, purchases are rotated among them.

Competency of Bidders—Even after the lowest responsive bidder is chosen, contractor evaluation is not over. Next the Signal Corps wants to assure that the bidder is also "responsible." For this, Signal Corps uses a group of experts known as the Contractor Evaluation Board. The group conducts a pre-award survey by analyzing: technical skills, adequacy of facilities, financial stability, and overall performance history. This information is gathered through direct field visits, or from background data, or both.

Final decision, however, always rests with Contracting Officer who acts on the Board's findings.

Factors in Evaluation — Under formal advertising procedures, technical evaluation of production type bids follows cut-and-dried methods. Usually, award is made to lowest bidder if he qualifies by: (1) fair price; (2) technical and financial responsibility; (3) having submitted a properly-filled bid; (4) "set-aside" aspects of his geographic labor-surplus status.

Set-Aside Influence—Set asides are procurements specifically earmarked for firms in labor-surplus areas or for small business. Department of Labor, twice a month, puts out an index listing labor-surplus areas.

There are two types of set-aside procedures for small business: the 100 per cent set-aside, and the partial set-aside. In the partial set-aside, usually 50 per cent is reserved for small business.

The 100 per cent set-asides are usually made under a procedure called small business restricted advertising. This means processing exactly as in formal advertising except that participation is restricted to small business only. Hence, award is made at quoted price to the small business with lowest bid provided again he qualifies as above.

In partial set-aside cases the method is different. Here, the non-set-aside portion of the procurement is awarded under normal formal ad-

vertising procedures. Next step is to pick the concern with whom negotiations should be held for the set-aside portion. To do this, the "magic figure" of 120 per cent is used. This is the cutoff point between concerns who can be considered for the set-aside award and those who cannot. This means that the price quoted for the non-set-aside portion must be within 120 per cent of price quoted by successful bidder on non-set-aside portion. Illustrative examples on this point may be obtained from USASSA Headquarters, Philadelphia.

Quality Control Function—Once award has been made, it is up to the contractor to furnish quality-control evidence. This includes detail description of inspection methods and quality-control systems used. Signal Corps emphasizes that "quality is a management function. As such, it must be transmitted from top management down to the grass roots of a company."

There are two applicable specifications to this end: MIL-Q-9859 (DOD), and MIL-I-45208 (Army). The first normally applies to major or complex equipments for which definitive specs do not exist; this also applies to R&D areas. The second spec applies mostly to production-type contracts.

Not by Price Alone—Although R&D procurements are publicized by Synopsis, they are not awarded on the basis of price alone. Technical aspects often wield more influence than price.

The Contracting Officer, with his team of experts, reviews all proposals for compliance with requirements, and for completeness.

He gets additional information where needed. He then evaluates each proposal technically on the following factors:

- Method of approach, originality and feasibility of proposed solution. Quality control and reliability aspects considered.
- Background, experience, and position of contractor in the field.
- Quality and quantity of manpower available.
- Adequacy and propriety of materials to be used.
- Adequacy of facilities for fabrication, testing, etc., and whether equipment and property are required to be Government furnished.
- Contractors ability to meet delivery schedules.

Understanding The Needs — If the key to successful bidding could be compressed into a few words, these would be: "Understand the technical requirements!" USASSA feels that heeding these few words insures the fullest response from Contracting Officer in helping you attain the technical objective. Don't be afraid to ask questions, or to ask for more information. For, the Contracting Officer and his team will be glad to assist you to submit a good proposal—this makes his task easier too.

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PROCUREMENT OFFICES

Headquarters

U. S. ASSA*
225 South 18th St.
Philadelphia 3, Pa.

Midwestern Regional Office, ASSA*
400 S. Jefferson St.
Chicago 7, Illinois

Western Regional Office, ASSA*
125 South Grand Ave.
Pasadena 2, Cal.

Laboratory Procurement Office
U. S. ASSA*
Fort Monmouth, N. J.

U. S. Army Electronic Proving Ground
U. S. ASSA*
Fort Huachuca, Arizona

Washington Procurement Office
U. S. ASSA*
Washington 25, D. C.

U. S. Army Pictorial Center
35-11 35th Avenue
Astoria, Long Island, N. Y.

U. S. Army
Alaska Communications System
550 Federal Office Bldg.
Seattle, Washington

Production Engineering
U. S. Army Signal Materiel
Support Agency
Fort Monmouth, N. J.

*Army Signal Supply Agency

EVALUATING AND TESTING

U. S. Army Electronic Proving Ground
Ft. Huachuca, Arizona
Attn: Deputy Commander for Tech Programs

R & D

U. S. Army Signal R & D Agency
Fort Monmouth, N. J.

West Coast Liaison Office
U. S. Army R & D Agency
125 S. Grand Ave.
Pasadena 2, Cal.

Project Advent information:
U. S. Army Advent Management Agency
Fort Monmouth, N. J.

COMBAT SURVEILLANCE AND TARGET ACQUISITION

U. S. Army Combat Surveillance Agency
Clarendon, Virginia

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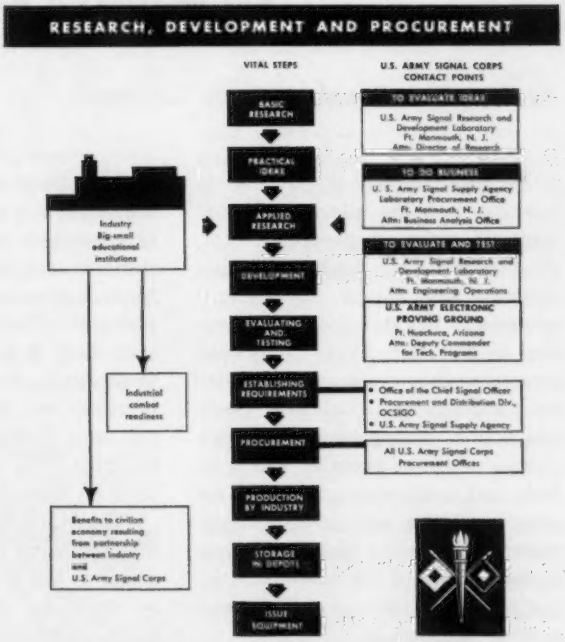

Progressive chart illustrates the vital steps the Signal Corps uses to translate ideas into equipment issued to the troops in the field.

PROPOSALS

Making them PAY-OFF

- *Too much top engineering talent, and too much money are being wasted in making proposals that have no reasonable chance of resulting in a contract.*
- *Lockheed planner thinks management can use better strategy, and better tactics in invading new markets.*

● Here is his plan . . . and why he thinks it will work.

by **Everett J. Daniels,** Lockheed, California

A vast volume of government business is being allocated on the basis of technical proposals. Yet, the subject of product-backing strategy and tactics for military contractors has received little attention in literature. Many companies give supervisory courses in personnel management; colleges cover production management; seminars discuss program planning and control; and conferences are held on other economic aspects of management. New-product planning comes in for a share of the attention, too, but always in the context of commercial products.

If the proposal budget may be thought of as the life-blood of a company, then certainly the proposal decision is the heart.

The Need—It is apparent from the start, that of the large number of companies entering some of the competitions, most must lose out. Many of these had no real expectation of winning. The experience they bought may have cost them dearly, since the money thus invested was money not available for more potentially profitable investment. This is the economic concept of opportunity cost.

Qualitatively, it would appear that for many of the losers the decision to bid at all was based upon an emotional feel for the competition. Certainly an experienced management should have a fine feel, particularly when it is buttressed by intelligence from the sales department. Applied feel is, after all, simply judgment, and decision-makers generally hold their positions through a past history of successful judgment. Nonetheless, it is felt that a more quantitative approach could have saved pain, and could have been of value to the top contenders as well. The latter approach will be taken here, for an optimization is otherwise impossible.

Objectives—Process of proposal-budget optimization starts with the setting of organizational objectives relative to both products and growth. There is nothing very profound about this statement: the setting of objectives is the first step in any management planning. Still, the subject is too significant to be glibly passed off.

Product objectives mean much more than platitudes and earnest hopes. Every company wants to build products of high reliability and quality, and to deliver them at the lowest possible cost. The kind of product objectives considered here are much more restrictive, and must be restrictive in order to be effective. The reference here is to the product category, and even such a category as guidance systems or space vehicles is too broad—unless the company's history is very strong in all aspects of the category or unless the corporate coffers are exceedingly well stocked.

This is an age of specialization, and there is a definite limit to the number of fields in which any company can become expert. It thus behooves the company (or division) to delimit its area of prime interest. In the case of space business, this means deciding on what aspect of the business the company is most interested in, what kind of missions it wishes to build its vehicles for (if vehicles are the choice), what customers it wishes to concentrate on.

How the management arrives at its specific product objectives is a subject beyond the scope of this article. Clearly the process requires a logical evaluation of existing technical skills and equipment, past history, company image in the eyes of the customer, the size of the market, the competitive picture, the order of magnitude of investment which the corporation is prepared to make, and the length of time before the organization is required to show a profit.

Next on the objectives list is the spelling out of financial objectives. These can usually be counted on to be generous; perhaps less generous will be the budget allocated to make them good. While a mathematical model could be presented relating budget allocations to financial objectives, this article is not concerned with either the total budget or the financial objectives per se. Notice is taken of them here only because there must be compatibility not only between financial objectives and budget, but also between product objectives and budjet. You can't enter the automobile manufacturing business on a budget consistent with the manufacture of bicycles.

The Decision to Bid—Objectives should not only be defined; they should be believed. If a request for proposal appears for a management decision, the first question should be simply this: Is it consistent with our objectives? That is to say, does this program lead us in the direction in which we want to go? We may also ask whether: the timing of the anticipated program funding is consistent with our sales objectives; and whether the program will build on our existing strengths, with implications on our probability of scoring heavily in the technical evaluation of our proposal and in the cost figure we will develop.

Advanced Systems Planner Daniels

objectives should be believed in

Foremost, however, are product objectives: if we insist on bidding on a program which is not in line with them, then we ought to change our stated objectives.

Next, we must ask what the alternatives might be. Proposal budgets are necessarily limited, and bidding on one implies a reduced ability to bid on later ones. If we anticipate a later request competitive for the same budget but more attractive to us, or if we feel that we need additional support of another key item, we had better decline this request.

Finally, we must assure ourselves that we are in a position to bid. We must determine the competitive picture to ascertain whether someone else has a fairly clear inside track. We must be sure that we have the people and the budget necessary to write the proposal, and the people and facilities available to perform the task if we win it.

How Much Is Enough? — Thus far, our hypothetical management has taken the first step toward optimizing its proposal budget: it has avoided a wasteful scattering of proposal ammunition. At some time, however, there must be a decision to bid, and the question of extent of investment in the bid becomes significant.

Simplest way to determine the extent of budget for the proposal is to count noses of people available and qualified to write the proposal, and multiply by the time available prior to submittal. While contracts have certainly been won with this approach, it is definitely not recommended.

Next higher in sophistication is the application of a criterion such as an expected payoff ratio. Here the anticipated size of the program is first multiplied by the fee ratio, yielding the anticipated fee to the winner. If the company's own probability of winning is multiplied by this last number, its "probable fee" results. The investment justified by the program will then bear some preassigned ratio to the company's together with appropriate probaprobable fee. Future potential of the program is generally included, bility and cost figures.

While both these methods have some value, they suffer in that they are too passive. They do not take adequate cognizance of the fact that the amount of effort expended can alter the probability of winning the award. Once this concept is appreciated and a quantitative-effect relationship on probability established, means are available for an optimization process.

For the present, let it be assumed that the award is based upon technical excellence alone. Further, assume that the technical quality of each proposal varies directly with the amount of effort which has gone into its background and preparation. Under these simplifying assumptions, winning the competition reduces to putting in more effort than each of the competitors.

It is certainly true that factors other then technical excellence affect a contract award. A complete proposal contains a management section and a cost section in addition to the technical portion. Even here, however, the proposal will almost always be stronger with additional effort. Cost-saving techniques will be able to receive more study, some possible R & D investigations may be ruled out, and

a more comprehensive management proposal can be presented.

This is not to deny the existence of other factors universally recognized as influential in some awards. Among these are customer orientation toward a competitor or an approach, distressed-area considerations, sales effort, saturation, or simply someone "due" to win. Some account could be taken of these "other" factors. While their consideration would significantly affect the actual probability of winning an award, there would be little effect on the optimum effort.

Use of the Technique — Most critical factor involved in the use of this optimization scheme is the estimate of the effort which the competitors will expend. Sales intelligence is, of course, the best basis if it is available, but this is generally pretty hard to come by. Without it, the company should put itself in the place of a competitor and either estimate what it would normally expend on a competition of this magnitude or apply some other technique, such as the expected payoff ratio. The estimates would require modification for super-size programs covering long time-spans, for study programs which provide advantages in future competitions, or for a program which might yield valuable commercial products.

It should be emphasized that the word "effort" used here does not imply proposal-effort alone. Equally valuable is the applied-research program which anticipates and lends support to the actual writing of the proposal. Such a program has the additional advantage of effort "in series" with the proposal, rather than "parallel" effort involving more people (some perhaps less qualified) and more coordination.

There are, of course, some disadvantages to this technique of greater emphasis on fewer proposals. It places all the budgetary eggs in fewer baskets, leaving the company in a more vulnerable position if the customer should cut a hole in one of the baskets by changing his mind about funding the program. It also places greater emphasis on being right about the course selected.

There will be occasions on which, after calculating the "optimum" level of effort as defined here, the company will decide that the prize does not justify the price. In this case, the company should simply not bid. The technique described does not attempt to answer such a judgment question; it states merely how hard a try is optimum if a try is to be made at all.

The above situation could easily arise if two companies should utilize the technique in the same competition. A condition analogous to a filling station "gas war" could result, and each would have to decide whether it was willing to play the game. In fact, the strategy suggested in any competition, in which one capable competitor appears to be making a particularly determined bid, would be: to treat the problem as that of a single competitor; calculate one's own effort requirements on that basis (approximately 40 per cent more than his); and decide whether the contract is worth that amount of effort.

Implications—It seems reasonable to ask what economic and scientific effects might result if all competitors adopted the philosophy expressed here. Certainly there would be fewer proposals submitted in any competition. Is this necessarily bad? Would the major contractors tend to "carve up" their markets into areas in which each was supreme? Consider these questions from the point of view of the companies and of the customer.

The effect on the companies should certainly be beneficial. As long as only a few companies apply the concentration principle, they will show a total of more successful attempts not only per proposal submitted, but also per total budget. With this benefit, a company could conceivably reduce its total allocation; more likely, it would apply the savings to greater emphasis on research, both basic and applied.

Even with most competitors concentrating, companies should experience net gains. Concentration demands more intensive preparation of proposals, backed by more in-house studies. Thus the companies would permit their proposal scientists—generally among their best talent—to dig more deeply into their problems. The result is a more thorough understanding, with which the company will be in a better position to submit unsolicited proposals or to develop commercial derivatives.

From government's point of view, our top technical talent is a valuable national resource. When it is spread too thin, it becomes a net national waste. The possible loss in ideas resulting from fewer proposals due to concentration would be overbalanced by the greater depth in the ideas presented. Instead of having twelve companies invent a wheel, there would perhaps be only four—leaving four to invent axles and four to invent tires—and wheels, axles, and tires would all be better for the added effort they would receive.

The result would be no more socialistic than laissez-faire capitalistic. It would be socialistic if the government were to dictate the areas of specialization for each company; it would be collusive if the companies were to agree to divide up the field. So long as each company is free to set its own objectives and to change them as new areas show promise, the effect is a more productively-efficient and inventive consequence of competitive capitalism.

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Men on the Move

W. C. Hobbs
North American

W. C. HOBBS elected a vice president at North American Aviation, W. F. SNELLING and GARY STROTH elected vice presidents of the Los Angeles Division.

UGO A. COTY joins Aerojet-General Corporation as assistant to the Azusa plant vice president.

DR. LESTER M. FIELD has been named assistant group executive of Hughes Aircraft Company's components group at Los Angeles.

R. L. Garman
General Precision

DAVID T. KIMBALL named vice president of both the Whittaker Controls and Whittaker Gyro divisions of Telecomputing Corp.

DR. R. L. GARMAN appointed to the newly created post of vice president and chief scientist at General Precision, Inc., also appointed was DAVID BALBER to the post of director of advanced product development.

CHARLES R. ABLE now vice president and general manager for missiles and space and JACKSON R. MC GOWEN vice president and general manager for aircraft at Douglas Aircraft Co.

RICHARD K. MOSHER has been promoted to the new post of vice president in charge of the Systems Div. of Laboratory For Electronics, Inc. in Boston.

HERBERT W. POLLOCK has been appointed as engineering manager of Polarad Electronics Corp. at Long Island City.

LEE N. MORTENSON has been named to the new position of manager, Research and Analysis Department at Wyle Laboratories.

MARK SHEPHERD, JR., named executive vice president with responsibility for all company operating activities and S. T. HARRIS named senior vice president for corporate development at Texas Instruments, Inc.

WILLIAM A. SIPPRELL has joined Guidance Technology, Inc., as vice president.

LT. GEN. E. R. QUESADA (USAF Ret.) elected to the board of directors at Edgerton, Germeshausen & Grier, Inc.

Continued on next page

C. R. ABLE
Douglas

J. R. McGowen
Douglas

E. R. Quesada
E. G. & G.

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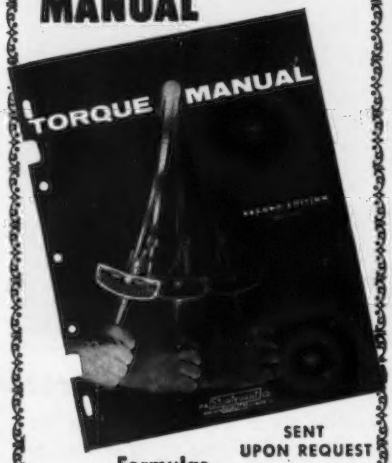

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Men On The Move

continued

WILLIAM H. LONG has been named manager of the Nuclear Materials and Propulsion Operation at General Electric's Flight Propulsion Laboratory department.

DR. JOHN W. BOND, JR., has been named director of military and space applications for the Geophysics Corporation of America.

ROYAL WELLER has been named to the post of director of engineering for the Space Systems Division of Lockheed Missiles & Space Company.

W. NORMAN STONE elected vice president and chief engineer of the Kaman Aircraft Corp.

E. N. SIZEMORE to head new regional office for Thiokol in Cocoa Beach, Florida. Mr. Sizemore was formerly head of the Field Services Office at Cape Canaveral.

M. B. RUFFIN elected president and chief executive of Chicago Aerial Industries, Inc. Ruffin was formerly executive vice president.

THOMAS F. DIXON has been appointed director of NASA's Office of Launch Vehicle Programs (OLVP).

DANIEL E. MURPHY appointed assistant to the president of Consolidated Electrodynamics Corp.

WILLIAM H. ENDERS has been appointed manager, advanced system projects, of RCA's aerospace communications and controls division at Burlington, Mass.

HARRY L. BENJAMIN, formerly assistant to the president of United Aircraft Products, Inc., has been appointed vice-president in charge of marketing and engineering.

R. E. MINNICK named as Aerojet-General corporate small business officer to carry out the corporation's Defense Subcontracting Small Business Program.

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This booklet concerns success in business. Authors and collaborators include many prominent names from business and industrial circles.—*Alexander Hamilton Institute*

Circle 50 on Inquiry Card for more data

High Purity Lithium

Data sheets on Lithium metal and Lithium Hydride include some interesting specs and a number of reference charts. Data sheets numbered 101 and 102.—*Foote Mineral Co.*

Circle 51 on Inquiry Card for more data

Refractory Metals

Report on refractory metals sheet rolling panel activities. Booklet describes functions and current status of the activities of the refractory metals sheet rolling program. Metals discussed include molybdenum, columbium, tantalum and tungsten. Limited number of copies available.—*National Academy of Sciences—Materials Advisory Board*

Circle 52 on Inquiry Card for more data

Sensors

New 4-page brochure on sensors describes how optical, infra-red, magnetic, electromagnetic and nuclear devices are used to inspect, control and measure.—*Designers For Industry, Inc.*

Circle 53 on Inquiry Card for more data

Information Searching

Brochure explains an electronic information searching service and the equipment used to search technical articles and documents on metals and related subjects.—*American Society For Metals*

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Nuclear/Space Materials

Quarterly bulletin deals with research, development and processing of rare metals used in nuclear reactors.—*Dresser Products, Inc.*

Circle 55 on Inquiry Card for more data

3D-TV

Technical manual on 3D-TV describes the operation of a system which optically converts closed circuit television to three dimensional pictures.—*Stereotronics Corp.*

Circle 56 on Inquiry Card for more data

Reliability Brochure

Introduces a reliability corporation and explains its purpose in being as well as its approach, personnel and facilities. Fields of interest are thoroughly covered and a typical reliability program is laid out.—*Astro Reliability Corp.*

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Titanium Products

Brochure describes advantages and applications of titanium products for the plating-anodizing industry.—*Astro-Fab, Inc.*

Circle 58 on Inquiry Card for more data

Silicone Products

Properties and applications of a wide range of silicone rubber products are outlined in a 12-page brochure. Publication describes definitions of silicone rubber, advantages, uses, physical properties, and product applications.—*Hewitt-Robbins*

Circle 59 on Inquiry Card for more data

High-Temp Alloys

Booklet describes alloys which are used in aircraft, aircraft engine, gas turbine, missile and other applications where corrosion resistance and strength at high temperature is required. — *Allegheny Ludlum Steel Corp.*

Circle 60 on Inquiry Card for more data

Facilities Brochure

Products and services in the following areas are covered—systems, electronics, gyrodynamics, components, computer and controls, and microwave. Text includes plant locations and personnel census.—*Kearfott Division, General Precision, Inc.*

Circle 61 on Inquiry Card for more data

IAS Information

"This is IAS" is a comprehensive and interesting introduction to the Institute of the Aerospace Sciences. Material includes member services and publications list.—*Institute of the Aerospace Sciences*

Circle 62 on Inquiry Card for more data

Battlefield Control

A new military battlefield control tool called Army Tactical Operations Central is illustrated in an 8-page brochure. System makes use of electronic computing and data processing equipment. — *Aeronutronic Div. Ford Motor Co.*

Circle 63 on Inquiry card for more data

High-Strength Steel

Recent developments in high-strength steels summarized in four page paper. Report discusses new techniques in tempering the 5 per cent chromium hot-work die steels.—*Defense Metals Information Center, Battelle Memorial Institute.*

Circle 64 on Inquiry Card for more data

Delrin Acetal Plastic

Booklet describes and illustrates design factors, including strength and dimensional stability. Contents also include use of Delrin acetal in gears, bearings and electrical applications. —*Cadillac Plastic & Chemical Co.*

Circle 65 on Inquiry Card for more data

Industrial Laminates

Technical bulletin gives detailed specifications, mechanical properties and electrical data on industrial laminates, molded plastics, vulcanized fibre and electrical insulations.—*Continental-Diamond Fibre Corp.*

Circle 66 on Inquiry Card for more data

Research Activities

Brochure describes the facilities and capabilities of a new research center. Areas of interest include communication theory and practice, data handling and infrared systems.—*Philco Research Div.*

Circle 67 on Inquiry Card for more data

Italian Economy

A brief outline of the evolution of the Italian economy in 1960. Contents include monetary circulation, cost of living, wages, prices, bank deposits, loans and stock exchange prices.—*Italian Investment Office*

Circle 68 on Inquiry Card for more data

Silicone Rubber

Publication describes the various silicone rubber compounds now available for use as wire and cable insulation. Tables showing properties, handling suggestions and applications are included. — *General Electric Silicone Prods. Dept.*

Circle 69 on Inquiry Card for more data

Guidance Systems

Brochure deals with guidance products and systems including those now under development. Short biogs of key personnel are also included.—*Kollsman Instrument Corp.*

Circle 70 on Inquiry Card for more data

How do you select a soldering iron?

...by wattage or delivered heat?

The wattage of an uncontrolled iron is no indication of delivered heat. Tip temperature varies under load from too hot to too cool. Sound connections require proper soldering temperature within a controlled range. With a high wattage iron that sags into the proper range, you pay an unnecessary premium and risk damage from too high heat.

A Weller Magnastat iron is temperature controlled at the tip. Efficient soldering temperature is maintained continuously by a thermo-magnetic sensing device. The iron never overheats . . . saves current when idling . . . and holds within ±3% variance of the specified temperature. Interchangeable tips provide either 750, 700 or 600°F. temperatures.

...by the pound or for operator efficiency?

With only half the weight, a Weller Magnastat iron does the work of an uncontrolled iron of much higher wattage. A 55 watt Magnastat iron weighs only 3 ounces. Operator efficiency is also aided by a delicate balance and constantly cool handle.

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MAGNASTAT

temperature controlled soldering irons

MODEL TC-552. 55 watts, for heat-sensitive soldering $9.00 list

MODEL TC-602. 75 watts, for medium soldering $10.00 list

MODEL TC-1202. 120 watts, for heavy soldering $11.50 list

Prices shown are for Magnastat Iron with tip and 2-wire cord. 3-wire cords available. Over 50 tip styles available in 3 temperature ranges.

SEND FOR NEW BULLETIN ON MAGNASTAT IRONS

WELLER ELECTRIC CORP. 601 Stone's Crossing Rd. Easton, Pa.

NEW LITERATURE

Worth Asking For

. . . continued

Digital Instrumentation

Twenty-page catalog, with price information and location of representatives, describes a line of high speed solid state and vacuum tube electronic counters, timers, preset counter-controllers, decade counting units and printers. — *Computer Measurements Co.*

Circle 71 on Inquiry Card for more data

Radiation Counters

Bulletin describes two high speed scalers for radiation counting in the clinical, industrial and nuclear research fields. Both are decade type units that operate with all basic nuclear detectors. These units will automatically signal any counting error due to tube or component failure.—*Nuclear Measurements Corp.*

Circle 72 on Inquiry Card for more data

Metal Teflon Hose

Technical bulletin describes a line of bronze wire braided hose containing an inner core of Teflon. Material includes applications, specifications, and a "how to order" section.—*Atlantic Metal Hose Co.*

Circle 73 on Inquiry Card for more data

Cable Assemblies

Description of facilities for assembling conductors into "tailored" cable with Neoprene or Polyvinyl Chloride jackets. Brochure also discusses capabilities in producing molded cable and the design, development and manufacturing of electromechanical equipment.—*Electro-Mechanics, Inc.*

Circle 74 on Inquiry Card for more data

Dry-Film Lubricants

Lubricants for extreme environmental conditions are the subject of this brochure. Described are the results of tests of inorganic, solid-film lubricant performance in liquid oxygen service.—*Alpha-Molykote Corp.*

Circle 75 on Inquiry Card for more data

PCM Telemetry

An "off the shelf" PCM telemetry system is described in an eight-page brochure. Evolution of PCM and the applications of PCM technology are also discussed.—*Radiation, Inc.*

Circle 76 on Inquiry Card for more data

Nickel Coating

Brochure describes a process for depositing nickel alloy coating on iron, copper, aluminum, titanium and their alloys without the use of electricity. — *General American Transportation Corp.*

Circle 77 on Inquiry Card for more data

Aerospace Support

Illustrated brochure contains on the site photographs of aerospace support and test equipment, nuclear equipment and installations, expansion joints, bellows and surge suppressors. —*Cook Electric Co.*

Circle 78 on Inquiry Card for more data

Facilities — Capabilities

Engineering, manufacturing and test facilities are photographically described in a 16-page brochure.—*General Electric Light Military Electronics Dept.*

Circle 79 on Inquiry Card for more data

High Vacuum Vapor Pumps

The key to high vacuum, performance characteristics of vapor pumps, pump selection and special pumping systems are a few of the areas covered in this very complete brochure. Descriptions and performance curves of glass mercury pumps, glass oil, metal oil/mercury and mechanical pumps and their uses are included.—*Consolidated Vacuum Corp.*

Circle 80 on Inquiry Card for more data

Thermal Protection

Abstracts of papers presented by fifteen of the nation's leading scientists in the field of thermal protection systems. Conference sponsored jointly by Arthur D. Little, Inc. and Air Force.—*Arthur D. Little, Inc.*

Circle 81 on Inquiry Card for more data

Instruments Catalog

Twenty-eight page catalog contains specifications and operating data on seven instruments for research and production control.—*Philips Electronics Instruments*

Circle 82 on Inquiry Card for more data

High Voltage Equipment

Catalog and applications manual covers a complete line of high voltage components and equipment and provides information on anti-corona terminations, high voltage DC supplies, power packs and meters.—*Universal Voltronics.*

Circle 83 on Inquiry Card for more data

Dust Control

A number of methods for controlling industrial dust and fumes are described in a 20-page bulletin.—*Pangborn Corp.*

Circle 84 on Inquiry Card for more data

NEW! from the TURCO Technical Film Library

FREE SHOWING!

Full Color TRAINING MOVIE

"HOW TO LOCATE FLAWS WITH DYE PENETRANTS"

Accurately — Simply Economically!

Seen and Acclaimed by over 5000 Maintenance, Production and Quality Control Engineers!

SEE: Production-line inspecting of aircraft wing spars!

SEE: In-lathe inspections without disturbing set-up!

SEE: Location of weld porosity in pressure vessels!

SEE: Mass production inspection of small parts!

SEE: Location of fractures in wheels and gears!

SEE: Detection of heat cracks in brake plates!

SEE: a "flaw's-eye" view of how dye penetrants really work through glass!

IN YOUR PLANT or location of your choice!

Now, your plant or technical group can learn the full story of flaw location with dye penetrants. See how dye penetrants provide greater inspection accuracy and speed at lowered cost for hundreds of industrial concerns whose inspection facilities range from huge multi-tank installations down to small $35 inspection kits. Witness *actual* dye penetrant inspections, *right in your own plant* or other location of your choice...all without any cost or obligation!

Produced by the Technical Film Staff of Turco, manufacturer of the Dy-Chek® inspection process, this 23-minute film visually demonstrates *every* aspect of dye penetrant inspecting from laboratory theory to authentic production-line techniques actually filmed on the spot during mass production inspections.

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1 "SNEAK PREVIEW"

– 4-page folder previews film in detail. Developed from producer's original "script." Leads you through each scene... start to finish. Shows how easily you can obtain film – no cost or obligation.

2 "INSIDE DYE PENETRANTS"

– 8-page folder frankly reveals what dye pentrants are and what they are not! Illustrates many successful case histories of dye pentrant use in industry today.

3 "How to perform DYE PENETRANT Inspections"

– 4-page technical folder details every aspect of dye penetrant inspections from precleaning to interpreting results. Contains valuable "Dwell Time Chart."

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measurement and control

of pressure and differential pressure

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DELTADYNE® SWITCHES
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Adjustable for signalling pressure and differential pressure from 0.25" wc to 200 psi (or psid) in systems to 5000 psi and −65° to +275°F; leak-proof. Units sound alarm, light bulb, turn motor on or off, operate valves — remotely or in place. $40 to $75

DELTADYNE INDICATORS

Adjustable and non-adjustable. Actuation 0.01 to 100 psi (or psid). For same pressure/temperature as switches. Red button pops to give visual indication of overpressure. $22 to $85

DELTADYNE GAUGES

For system pressures to 3000 psi; indication from 0 to 60 psi differential; leak-proof — no moving seals; high-visibility scale. 0 to 60 psid, 3000 psi w.p. model. $92

TRANSMITTERS Complete with remote or in-place recorder.

Extended pressure and temperature ranges available in all instruments.

OFF-THE-SHELF OR CUSTOM-ENGINEERED FOR

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Read or control tank levels, and pressure drops across filters, heat exchangers, orifices for flow metering, gas adsorbers and many other types of equipment. Learn more about the cost and service advantages of these units.

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Aircraft Porous Media, Inc.

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PALL

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Circle 26 on Inquiry Card

NEW LITERATURE

Worth Asking For

. . . continued

Brass Specs

Booklet contains data on composition, specifications, properties and other technical information concerning temper, tensile, melting point and electrical conductivity of brass wire, rod and strip.—*Riverside Alloy Metal Div. H. K. Porter Co., Inc.*

Circle 85 on Inquiry Card for more data

Waveguide Chart

Wall chart of waveguide components hangs with each page extended for easy reference. Self adhering picture hook sent along with each copy. —*Microtech, Inc.*

Circle 86 on Inquiry Card for more data

Liquid Oxygen Cylinders

Booklet describes a cylinder with a capacity of 3000 cubic feet. Unit weighs 463 lbs and is said to require only 1/3 the space of its equivalent in high pressure cylinders.—*Linde Co.*

Circle 87 on Inquiry Card for more data

R&D Facilities

Eight-page bulletin describes the capabilities of a company for conducting research on formulating, processing and evaluating minerals and ceramic products.—*Gladding, McBean & Co.*

Circle 88 on Inquiry Card for more data

Split Body Valves

Details on construction and operation of a line of split body control valves offered in a 16-page brochure. Complete specifications and ordering information as well as interesting valve sizing formulae. — *Conoflow Corp.*

Circle 89 on Inquiry Card for more data

Nitrile Silicone Fluids

Technical bulletin with tables and text showing typical properties of available grades as well as suggested uses. Presence of nitrile groups gives these fluids high polarity and high dielectric constant.—*General Electric, Silicone Prod. Dept.*

Circle 90 on Inquiry Card for more data

Transfer Voltmeter

Brochure describes an instrument that enables an unknown ac voltage to be measured in terms of a dc voltage.—*Ballantine Laboratories*

Circle 91 on Inquiry Card for more data

TOTAL TEMPERATURE PROBES
PITOT-STATIC TUBES

ILLUSTRATED MODELS

MODEL 850 Meets Mach 3 requirements of MIL-P-25757A (USAF).

MODEL 103 Mach 5 total temperature probe can be used to temperatures of 1500 C°.

MODEL 101 Mach 3 total temperature probe. Meets requirements of MIL-P-25726 (USAF).

MODEL 102 Mach 3 Deiced total temperature probe. Accurately measures total temperature during deicing.

Write for Short Form Catalog No. 66030

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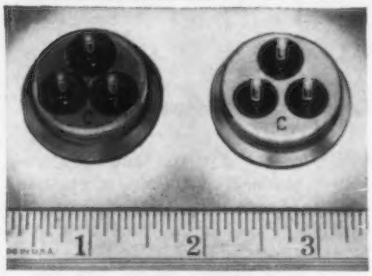
ROSEMOUNT ENGINEERING COMPANY

4912 West 78th St. Minneapolis 24, Minn

Circle 27 on Inquiry Card



FUSED GLASS AND METAL MISSILE PARTS CLEANED QUICKLY AND WITHOUT DAMAGE TO GLASS GLAZE
***with* VAPOR BLAST**
Liquid Honing®

Vapor Blast Liquid Honing process cleans metals fused to glass without removing glaze or damaging the glass.

Yet the metal parts are thoroughly cleaned, burrs removed, in shortest possible time.

Bring or send parts for test cleaning. No obligation.

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Circle 28 on Inquiry Card

NEW Materials

Hard Harness

Hard Harness for electrical wiring, molded of polyester-fiberglass pre-preg to fit contours of installation site is said to save space and

weight, improve physical and electrical strength and cut maintenance. Conventional aircraft wiring harness (left) carries same number of wires of the same gauge as the hard harness (right).—*Ling-Temco-Vought, Inc.*

Circle 92 on Inquiry Card for more data

Asbestos-Base Plastic

Asbestos-base reinforced plastics are said to have good machining properties, thermal insulation, heat resistance, good ablation performance and good impact resistance. It is claimed that these materials are particularly suited for use as motor lines, exhaust cones and other rocket components.—*Taylor Fibre Co.*

Circle 93 on Inquiry Card for more data

Rhenium-Tungsten Alloy

Rhenium-Tungsten alloy strip, rod, and wire, is said to provide increased reliability at high temp for missile, nuclear and electronic applications. Alloy has operating temp up to 5400° F, retains its ductility and does not become brittle upon recrystallization. —*Chase Brass & Copper Co.*

Circle 94 on Inquiry Card for more data

Solid Propellant

Polycarbutene-R is made from a production-type liquid polymer of butadiene and acrylic acid. Test-firings, from −100° to 180° F, without failure are claimed. An improved liner has been developed for the propellant.—*Grand Central Rocket Co.*

Circle 95 on Inquiry Card for more data

Lithium Hydride

High purity of lithium hydride (99+ per cent) now being produced opens new application areas. LiH is a crystalline solid similar in appearance to the other alkali metal hydrides but is more stable with respect to thermal dissociation. Possible uses now include shielding materials and heat transfer applications. The high purity factor limits the corrosive effects of oxides and nitrides previously found at higher temps. LiH is now being used as a light weight hydrogen source.—*Foote Mineral Co.*

Circle 96 on Inquiry Card for more data

Forged Magnesium

Large forged magnesium containers are being forged on what is said to be the world's largest closed die forging press with a 50,000 ton capacity. Picture shows 40 in. diam

half of sphere that will be used to carry Echo A 12 into orbit next year. —*Wyman-Gordon Co.*

Circle 97 on Inquiry Card for more data

Cesium

High purity cesium, is packaged in vacuum or under argon gas, as exposure to oxygen causes it to burn and contact with water causes a vio-

lent explosion. The alkali metal which has a melting point of 83° F is being used in ion engine studies. Cesium is available in steel and glass containers as well as multi-ampuled porcupine package shown.—*Dow Chemical Co.*

Circle 98 on Inquiry Card for more data

Pressure-Sensitive Paint

It is claimed that one drop of Celab pressure sensitive paint makes a pressure-transducer having almost no weight or volume and that it can be applied to any metal or conducting surface. When vacuum coated it forms a barometric pickup. Placed over a magnet or solenoid, it can be a solid state relay.—*Clark Electronic Laboratories.*

Circle 99 on Inquiry Card for more data

High Purity Nitrogen

Gas or liquid nitrogen is produced from an automatic plant. Gas is available from the plant at a suitable distribution pressure and a portion of output is taken and stored as liquid. All components of the plant are packaged units. Plants are available with capacities from 3000 to 100,000 SCFH.—*Superior Air Products Co.*

Circle 100 on Inquiry Card for more data

. . . continued on next page

WORLD'S MOST ACCURATE OPTICAL DIVIDING HEAD

VINCO GUARANTEES the Optical Master Inspection Dividing Head to be accurate within ± 1 second of arc; the ball bearing spindle runout to be 25 MILLIONTHS of an inch, total indicator reading; the master disc graduations to be spaced to an accuracy within ± ½ second of arc.

Shown above is a heavy duty dividing head and a dual recorder console with a ball slide electronic indicator stand. This ultra precision equipment will check and record tooth to tooth errors and accumulated errors to within 50 millionths of an inch on a 15" D.P. gear. Single recorder consoles are available.

DIVIDING HEAD APPLICATIONS

- Inspection of missile guidance system components.
- Measurement of gear and spline spacing and bore relationships.
- Calibration of index plates, involute and master involute profiles.
- Calibration of lead bars or helical precision components.
- Inspection of two and three dimensional cams as well as ellipses, cycloids, etc.
- Measurement of angular transmission of motion by gears and gear trains.
- Measurement of angular displacement of turntables.

SEND FOR THIS FREE EIGHT PAGE BROCHURE. THE DIVIDING HEAD IS FULLY ILLUSTRATED AND EXPLAINED.

A 720 TOOTH, 32 D.P. 14½° P.A. PRECISION GEAR

Tolerances on this 22.500" P.D. gear are .0002" involute profile; .0003" T.T.E.; .0006" T.C.E. The same craftsmen who build the world's most accurate dividing head produce gears of even closer tolerances daily for use in missile guidance systems, jet aircraft, instrumentation or wherever needed. **Call Vinco on your sub-contract requirements.**

VINCO DIV., VINCO CORP.

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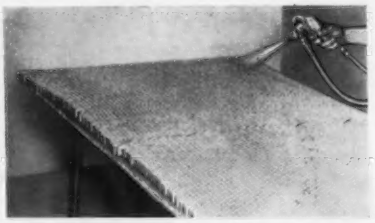
NEW Materials

continued

Dry Spray Adhesive

High strength, heat resistant adhesive can be spray applied in a relatively dry form and requires only contact pressure for bonding. Synthetic rubber base adhesive is also claimed



to be good for the fabrication of honeycomb sandwich panels and to have a temp range of −30° F to 250° F.—*Minnesota Mining & Mfg. Co.*

Circle 101 on Inquiry Card for more data

Tungsten Alloys

Thin section structural shapes in tungsten alloys which melt at temp above 6000° F can be forged by new process. Additional claims include the forging of difficult to achieve tolerances such as web and rib thickness of 0.130 plus or minus 0.015, surface finish of 30 rms and draft angles as low as one degree.—*Thompson Ramo Wooldridge Inc.*

Circle 150 on Inquiry Card for more data

Metal To Metal Bond

Two-part thermosetting epoxy resin is said to provide an unusually strong yet flexible adhesive which is highly resistant to impact for metal to metal bonding. Temp range is −40° F to 250° F.—*Miracle Adhesives Corp.*

Circle 102 on Inquiry Card for more data

Insulating Tape

Flexible insulating tape for Class B type layer and wrapper service features high resistance to heat, tear, and creasing with improved heat aging characteristics. Tape is composed of Dacron warp fibers and glass fill fibers treated with varnish. Material also available in 36 in. fabric.—*Westinghouse Electric Corp.*

Circle 103 on Inquiry Card for more data

Sintered Titanium Parts

Sintered Titanium parts are said to be strong, light and ductile, with yield strength of 133,000 psi, tensile

of 146,000 psi and have good corrosion and erosion resistance. Powder metallurgy eliminates scrap. Size is limited to 35 sq in. cross section and 6 in. thickness.—*Clevite Corp.*

Circle 104 on Inquiry Card for more data

Rare Earth Metals

Fabricated forms of rare earth metals and oxides in wire, rod, sheets, strip· foil, ingots and high-density pellets and powders are available. they are supplied as pure metals or alloys.—*Michigan Chemical Corp.*

Circle 105 on Inquiry Card for more data

Glass Insulation

Thermal and acoustical insulating material made of high-density fibrous glass is coated on one side against moisture penetration with a fire-resistant asbestos fiber mastic. Fiber mastic coating is available as a separate item.—*Fibrous Glass Products, Inc.*

Circle 106 on Inquiry Card for more data

Large Teflon Sections

Section weighing 210 lb, is said to be largest teflon billet ever molded. Tube has 12 in. outside diam and is

24 in. long. Unit shown is being X-rayed for internal voids or fractures. Billet, after machining, will be used on missile project prototype.—*Raybestos-Manhattan, Inc.*

Circle 107 on Inquiry Card for more data

Epoxy Cement

Fast setting cement for strain gage application, sets in three hours at room temp or in minutes with heat application. Operating temp limits are 200° F (static) and 250° F (dynamic). B-3 cement can be used on smooth or rough surfaces.—*Budd Co.*

Circle 108 on Inquiry Card for more data

Silicone Plate

Silicone plate is said to have excellent electrical properties and high

. . . *continued on next page*

...when you need all 4!

1. SWIVEL MOTION
2. GIMBAL MOTION

Provision for

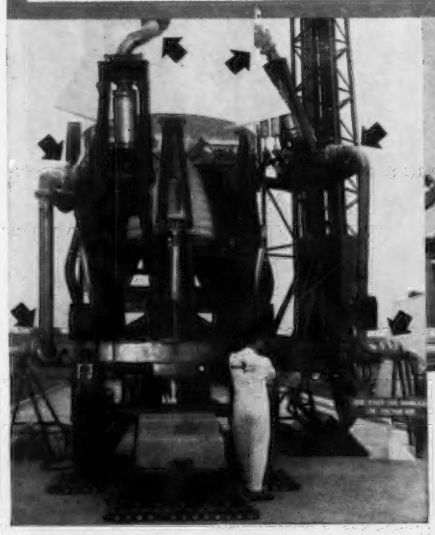
3. THERMAL CONTRACTION

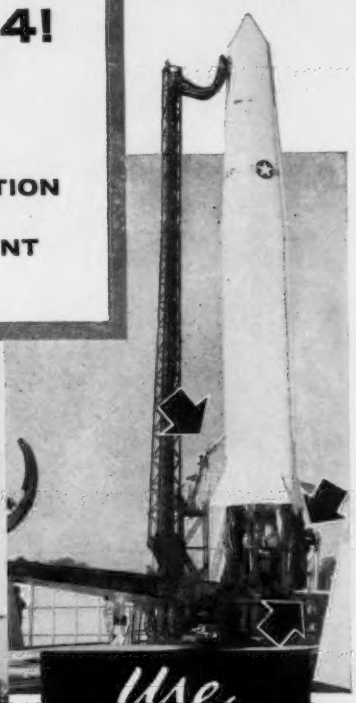
and Expansion in Fluid Lines

4. ACCURATE ALIGNMENT

of Piping

Photos: Douglas-Air Force Thor IRBM.





Use BARCO Flexible BALL JOINTS

. . . in Missile Fueling Lines

Fluid lines for fueling missiles present complex problems. Barco Flexible Ball Joints solve these problems because ONLY BARCO can give you *gimbal motion* combined with *swivel motion* in hook-ups that allow for *thermal contraction* or *expansion* and still permit precise *positioning* of lines.

Barco joints are approved for missile service. They are used in lines conveying fluid fuels and oxidizers, including liquid oxygen, white fuming and red fuming nitric acid, and hydrogen peroxide. Your choice of sizes, styles, and types to meet current project requirements.

Barco engineers can give you assistance and time saving recommendations based on detailed experience with almost all significant projects since the beginning. Barco is a dependable source of supply, also offering possibilities for MINIMUM COST. *Check with Barco—IT PAYS!*

SEND FOR LITERATURE
CATALOG 233—"Flexible Ball Joints for Handling Liquid Oxygen and Missile Fuels."
CATALOG 2698—"Plane and Self-Aligning Swivel Joints for Hydraulic Service."

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FLEXIBILITY FOR METAL PIPING
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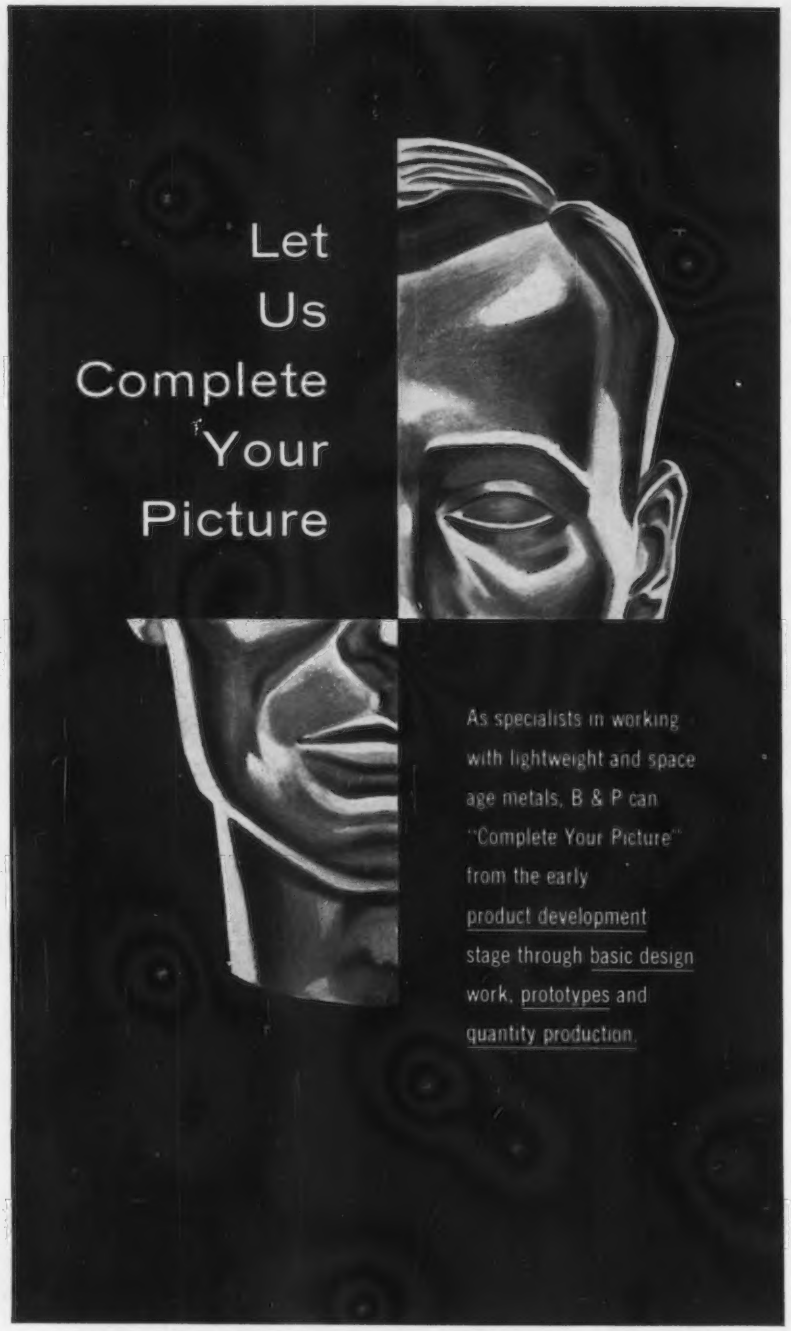
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Offices in: New York, Washington, Los Angeles (Long Beach), Boston (Cambridge), Dayton, Milwaukee (Waukesha)

NEW Materials

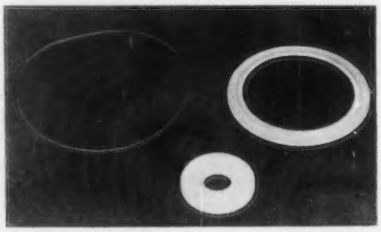
continued

impact strength for applications requiring class H insulation temp. Economy-grade plate is made in sizes up to 48 x 96 in. and thicknesses of 1/32 to 2 in.—*Westinghouse Electric Corp.*

Circle 109 on Inquiry Card for more data

Thermoplastic Resin

Features of thermoplastic resin, Kel-F 81, include: thermal stability from —400° to 400° F, abrasion re-

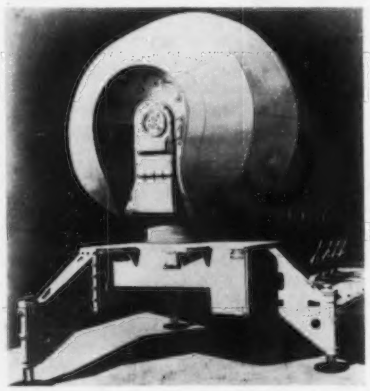


sistance, chemical resistance, excellent electrical properties, infrared transmission qualities and zero moisture absorption. Varying degrees of transparency can be induced by processing methods.—*Minnesota Mining & Mfg. Co.*

Circle 110 on Inquiry Card for more data

Silicone Rubber

Silicone rubber is being used to coat Radome covers. Covers treated with the material are said to remain flexible at all temp extremes. Mate-



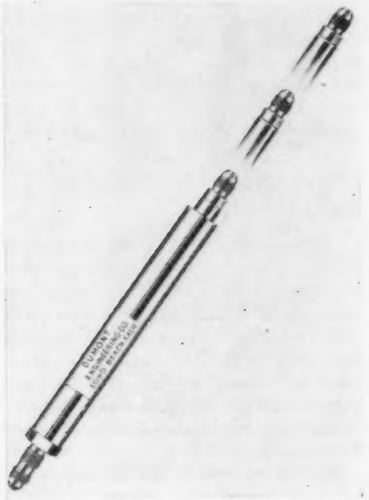
rial, SE-100, is applied as a white, putty-like substance and heat cured to the fabric.—*General Electric, Silicone Products Dept.*

Circle 111 on Inquiry Card for more data

NEW Electronic Products

Extension Fitting

Swivel fitting for missile fluid systems is capable of extending 6 in. at its rotating end. Unit should eliminate the coiling of flexible lines while



joining two sections of a missile. Cut illustrates extension feature, actual assembly is 10 in. long and ¾ in. in dia.—*Dumont Engineering Co.*

Circle 112 on Inquiry Card for more data

Spark Gap

Ceramic-metal, triggered spark gap with 70kv hold-off voltage is said to handle peak currents of greater than 10,000 amperes. Triggering is accomplished by a low energy, 25kv, minimum, pulse and delay time is 0.5 microsecond at 80 per cent of max voltage.—*Edgerton, Germeshausen & Grier, Inc.*

Circle 113 on Inquiry Card for more data

Nylon Grommet

Caterpillar grommet called the "Pipcat" is designed for use with 10 to 24 gauge sheet with holes over 3 in. in dia. May be used in standard length of 10 ins or combined to fit any size hole. In larger size applications it is necessary to use a commercial solvent to hold the grommet to metal but in smaller sizes the tension will hold it to any surface.—*Plastiguide Mfg. Corp.*

Circle 114 on Inquiry Card for more data

Wire Indentifiers

Polyvinylchloride markers are available for AWG 18 or smaller wires. Called "Z" Beta markers, they are one-piece, closed, flexible units with an expandable accordion type pleat. Markings include single numbers 0-9, letters A-Z as well as symbols commonly used in the electronics field. Multiple combinations of these markings are also available. Colors include white, black, blue, green, yellow and red.—*Electrovert, Inc.*

Circle 115 on Inquiry Card for more data

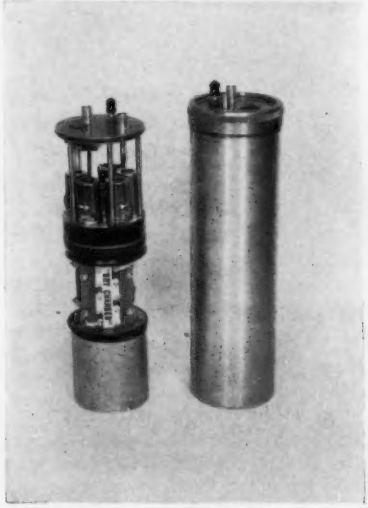
One-Piece Leads

Necked-down lead wires for glass sealing applications eliminate the welded joint. Leads are 3 in. long and are available in sizes from .020 to .050 in. in dia, which may be necked-down by as much as 50 per cent of the original wire size.—*Art Wire and Stamping Co.*

Circle 116 on Inquiry Card for more data

Transponder

New unit for flight test operations of missiles and rockets. It doubles the frequency of the signal received from the ground transmitter and transmits

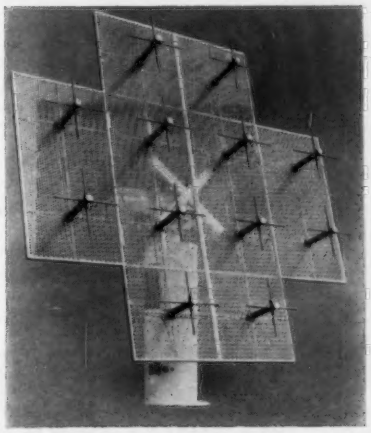


on another frequency with power for clear reception at the ground station. The Doppler effect is utilized to determine speed and position of the test vehicle.—*Frequency Standards.*

Circle 117 on Inquiry Card for more data

Dipole Array

Two-dimensional telemetering, receiving and tracking antenna, designated Model AD-250. Maker claims



unit can operate independently on two orthogonal linear polarizations or two circular polarizations of opposite screw sense.—*Rantec Corp.*

Circle 118 on Inquiry Card for more data

Infrared Source

Weighing three ounces and .75 in. in diameter by 1.5 in. long, the device will find application in instrument and optical system calibration, missile and space vehicle tracking and control, target tracking, and field testing. The device is initiated by an electrically energized squib which ignites a deflagrating pyrotechnic mixture surrounding a conical cavity radiator. Thermal energy, approaching 2000°K, is transferred to the conical cavity radiator and the resultant electromagnetic radiation is emitted at the base of the cone.—*Special Devices, Inc.*

Circle 119 on Inquiry Card for more data

Valve Actuator

Electronic unit can be mounted on any type of reciprocating or rotary stem valve. The actuator contains an electronic balancing relay assembly, which accepts an ac or dc control signal to operate the motor. Motor is oil-immersed and has an output torque from 25 to 150 ft/lbs, at speeds from ½ to 5 rpm.—*Electro-Mech Corp.*

Circle 120 on Inquiry Card for more data

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Rugged . . Mobile . . for Production, Installation and Maintenance Testing

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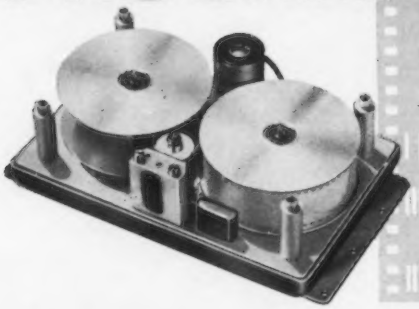

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- *Jet Engine Testing*
- *Industrial*

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NEW Electronic Products

continued

Ground Radar Check

Portable radar test set provides ground checkout of airborne radar, without physical connection to the aircraft. Designated Model 121, the set was developed for "on the ramp" testing of weather, navigation, and anti-collision radar systems, as well as radio altimeters. Company claims that complete checkout time has been reduced from three hours to about thirty minutes.—*Republic Electronic Industries Corp.*

Circle 121 on Inquiry Card for more data

Table Drive

Gyro rate table drive couples a small servo motor to a rate table to produce bi-directional drive of the table. Drive is supported on two pivot points and is spring loaded against the table gear. A dual gear drive train is "loaded" or "strained" to provide a constant residual strain torque, eliminating backlash.—*United Control Systems, Inc.*

Circle 122 on Inquiry Card for more data

Floated Gyro

Miniature two-degree-of-freedom gyro was designed for long duration space guidance systems. Unit is said to be one-quarter the weight and one-fifth the volume of those now in use. Designated Model G8, the gyro contains an inner gimbal which is a sealed floated beryllium sphere containing the wheel assembly. Two degrees of freedom are provided by interposing a floated solid beryllium ring between the inner gimbal and the external housing. — *American Bosch Arma Corp.*

Circle 123 on Inquiry Card for more data

Phase Shifter

New broadband microwave unit is said to provide a considerable amount of phases shift over an extended bandwidth. The drive requirement for this unit is 800MA of dc current, which can be modified for other current levels and for ac modulation. The length of 7¾ inches, bandwidth, center frequency and phase shift can also be varied.—*E&M Laboratories.*

Circle 124 on Inquiry Card for more data

NEW Parts and Components

Vibration Measuring

Vibration measuring system for use in sinusoidal laboratory vibration

testing permits continuous automatic recording of data from accelerometer signals, including phase, distortion, and amplitude. — *Chadwick-Helmuth*

Circle 125 on Inquiry Card for more data

Cryostat

Open loop cryostat (top center) consists of threaded gas inlet and longer throttle tube on which finned 30 per cent cupro nickle tubing drawn to .016 in. outside diam has been spiraled. The cryostat cools infrared detection device (below center). Detector is vacuum insulated in Dewar

package with detector lens window at bottom.—*Superior Tube Co.*

Circle 126 on Inquiry Card for more data

Universal Testing

Automatic testing machine is said to accommodate highly-exacting test requirements for determining physical properties of metals, plastics, ceramics, cermets, cloth and paper. Hydraulic-powered TM-6 is available in 15,000, 30,000 or 60,000 lb capacity, with a hydraulic power stroke of 12 in. Machine is automatically controlled and will test materials in tension, compression, bending, fatigue, creep, creep-relaxation and recovery. —*Marquardt Corp.*

Circle 127 on Inquiry Card for more data

AGE Motor

Motor was designed for cooling units in aerospace ground equipment installations. 3800 rpm, 400 cycle, 12-pole partial motor is said to be directly interchangeable with 60 cycle,

2-pole motors and built for hermetically sealed operation.—*U. S. Electrical Motors*

Circle 128 on Inquiry Card for more data

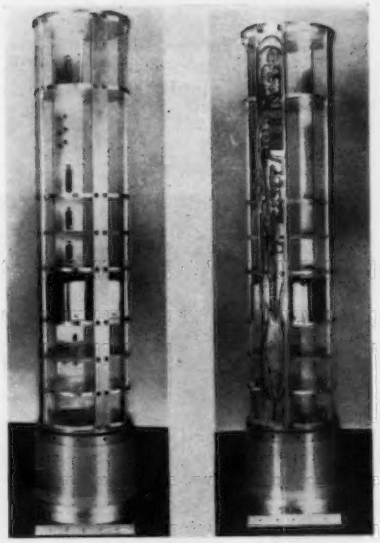
Solid Rocket

Solid propellant rocket motors are designed for sounding vehicles, sled and missile propulsion. Gila series utilizes a hot-particle, shockless type igniter with electric initiation. Units are housed in an alloy steel case 101.5 in. long with a 9 in. diam. Gila I provides 33,000 lb thrust for 1.2 sec; Gila II, 47,000 lb thrust for 11 sec; and Gila III, 21,300 lb thrust for 3.1 sec.—*Rocket Power Inc.*

Circle 129 on Inquiry Card for more data

Rack for Rockets

Standardized instrumentation rack for upper atmosphere sounding rock-

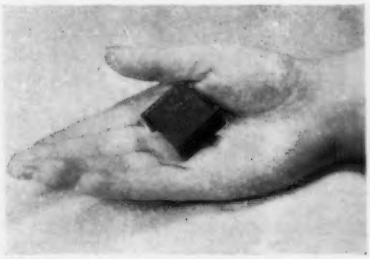


ets is designed to accommodate equipment payloads of variable size and configuration. It is claimed that these racks are capable of withstanding severe shock and vibration. Model available for Asp, Cajun and Apache rockets stands 25 1/16 in. high and weighs 8.5 lb empty. Lengths can be varied.—*Geophysics Corp. of America*

Circle 130 on Inquiry Card for more data

Mini Data System

Midas (Miniature Data Acquisition System) is a real-time FM/FM, multi-channel telemetry system. Midas is said to be capable of sensing and transmitting respiration rate, heart-



beat, pressure, strain, acceleration, etc., of man and machine.—*Unilectron*

Circle 131 on Inquiry Card for more data

. . . continued on next page

NEW

Parts and Components

continued

Mini Accelerometer

Miniature accelerometer is said to have low cross sensitivity. Model 106, weighing 0.3 oz is designed to operate from −65° F to +360° F and is equipped with insulated mounting, hermetic connector and stainless steel case.—*United Aerotronics Corp.*

Circle 132 on Inquiry Card for more data

SCR Controller

Magnetic SCR Controller is said of reliably firing various silicon conto provide a simple, efficient method trolled rectifiers. Device controls the firing point of the SCR in terms of the phase angle of the supply voltage. —*Vickers, Inc.*

Circle 133 on Inquiry Card for more data

Custom Filters

Custom-designed for the new B-52H bomber, filters are said to be able to operate at altitudes of 50,000 ft, at

temp from −65 to 250° F, at a fuel flow rate of 14,300 pph. When differential pressure across the filter assembly increases to a predetermined level, a red flag pops up.—*Purolator Products, Inc.*

Circle 134 on Inquiry Card for more data

Vacuum Pump

Vacuum pump with 32 in. diam was developed for evacuation of large space chambers. It is claimed that this oil-diffusion pump consistently provides a plateau speed of 52,000 liters per sec through out the 3×10^{-5} to 4×10^{-4} mm Hg pressure range.—*Consolidated Vacuum Corp.*

Circle 135 on Inquiry Card for more data

Cryogenic Sensors

Cryogenic sensors are said to accurately measure temp as low as 4° Kelvin (−269° C). Sensors are germanium semi-conductors designed for application in test and operational

phases of space vehicles using liquid helium and nitrogen and for use in calibration and standards labs. Temp range is 4° to 40° Kelvin.—*Minneapolis-Honeywell Regulator Co.*

Circle 136 on Inquiry Card for more data

The "Big Four" land-based strategic surface-to-surface U.S. missiles—Douglas Thor, Convair Atlas, Martin Titan II, and Boeing Minuteman—are backed by multiple production ground support air conditioning units engineered and manufactured by the C. G. Hokanson Company, Inc. This "grand slam" award of all four competitive *production* contracts is the best evidence that the name Hokanson is a guarantee of design excellence, performance, and reliability in ground support air conditioning.

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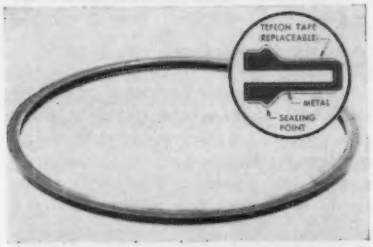
Hokanson

Hi/Low Temp Seal

Seal, called Naflex Seal, is said to provide leakproof sealing through high and low extremes of tempera-



ture and be re-used repeatedly. Seal is available in sizes from one to 20 in. from stock.—*Rocketdyne*

Circle 137 on Inquiry Card for more data

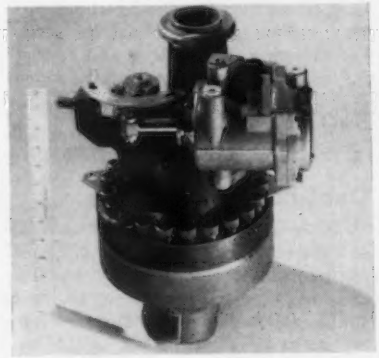
Fire Extinguisher

Light-weight aircraft fire extinguisher for use against in-flight fires in engine compartments, fuel and oil compartments and other fire zones are available in seven sizes from 86 to 1050 cu/in. capacity. Units are designed for the halegonated extinguishing agents.—*Solrac Inc.*

Circle 138 on Inquiry Card for more data

Gate Valve

Two-way swinging gate valve for control of water flow in a recirculating nuclear reactor cooling system has



2 in. port diam. Valve is said to operate at temp up to 600° F at 2000 psig.—*Chandler Evans Corp.*

Circle 139 on Inquiry Card for more data

Gyro Instrument

Gyro instrument designed as operational and training aid for aircraft is related to direct reading of attitude performance. Instrument designated model SD-2307 is called the Vecto Gyro.—*Vecto Instrument Corp.*

Circle 140 on Inquiry Card for more data

Metal Bellows

Supported and unsupported bellows and bellows assemblies are designed for use as pressure seals, flexible joints or vibration dampeners in gas or liquid transmission lines. Available in sizes from 1 to 12 in., bellows are said to be useable for high pressure or vacuum and temp extremes applications.—*Avica Corp.*

Circle 141 on Inquiry Card for more data

High-Speed Photo Titler

High-speed system for printing information on aerial photographs, known as a rapid automatic film titling unit, was designed for B-58 system. Equipment accommodates 35mm, 70mm and 9½ in. film. It is claimed that negatives can be titled at 15 to 25 ft/min immediately after processing.—*Eastman Kodak Co.*

Circle 142 on Inquiry Card for more data

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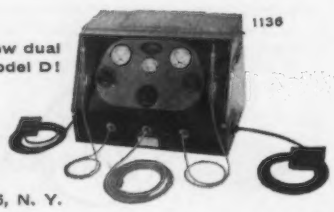

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NEW Production Equipment

Corner Cutter

An electrical-discharge machine that will disintegrate metal to form any shape. An electrode of any shape or size is attached to the discharge end of the machine, this sends thousands of sparks per minute into the

work piece "cutting" away the metal. This technique can be used for forming, piercing, die sinking and surfacing any electrically conductive material. — *General Dynamics/Astronautics.*

Circle 143 on Inquiry Card for more data

Dual-Purpose Scale

Scale for ratio counting as well as direct weighing was designed for manufacturers of screw machine products, plastics, electronics and similar industries where direct weighing up to 40 lbs is needed. Scale converts its function from one of ratio counting to one of direct weighing with the movement of one lever. Available with four standard dials.— *Pennsylvania Scale Co.*

Circle 144 on Inquiry Card for more data

Metallurgical Chilling

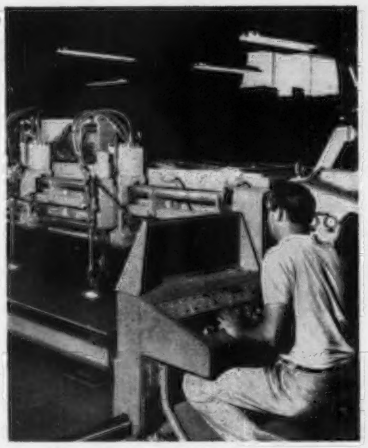
Model ST-120-15 is a chamber which measures 36 x 24 x 30 ins and has a capacity of 4,000 BTu/hr at —120°F. Chamber will chill 200 lbs of steel per hour from ambient to —120 for zerolling stainless steel. The unit is insulated and the electrical

requirements are 440-60-3 with a 115 volt control circuit.—*Cincinnati Sub-Zero Products.*

Circle 145 on Inquiry Card for more data

Controlled Flame-Cutting

Numerically controlled rectilinear bridge type unit can cut straight lines and contours. Unit will accommodate any length plate up to 22 ft in width and 6 in. thick. Dimensional data extracted from engineering drawings is transferred to paper tape, this tape



provides input instructions for the machine. After initial positioning of the work piece all operations become automatic. Equipped with four cutting torches, the unit is said to have an accuracy of ±1/64 in.—*Air Reduction Sales Co.*

Circle 146 on Inquiry Card for more data

Test Furnace

Vacuum tensile test furnace is used to determine strengths of space-age metals under conditions designed to simulate those of outer space. The heated zone is 2 in ID x 6 in high and utilizes two single phase elements. Power supply is rated at 22½ KW, 230 V and 60 cycles. Temperatures up to 3500 deg F at a vacuum from 1 x 10^{-4} to 1 x 10^{-5} mm Hg are obtainable.—*High Vacuum Equipment Corp.*

Circle 147 on Inquiry Card for more data

Automatic Cylinder Forming

New unit automatically forms and side seam welds steel container shells. This unit can be used in conjunction with automatic sheet feeding equipment or the sheets can be fed to the roll manually. Maximum cylinder diameter is 24 in with a 40 in length, unit welds at a rate of from 20 to 60 fpm with 16 to 22 gauge steel.—*Federal-Warco Div., The McKay Machine Co.*

Circle 148 on Inquiry Card for more data

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PLANT ADDRESS .....

CITY .....**ZONE**.....**STATE**.....

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A. Your Job Function

....1. Management
....2. Design & Engineering
....3. Production
....4. Procurement

B. Type of Plant or Facility

....1. Airframe
....2. Propulsion
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....4. Mechanical Systems & Parts
....5. Raw & Processed Material
....6. Engineering & Research Services
....7. Military & Government Facilities
....8. Parts & Supplies
....9. Plant or Test Equipment
....0. Other

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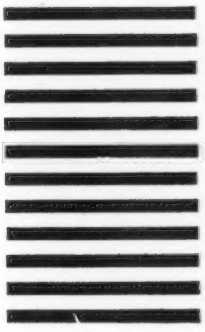

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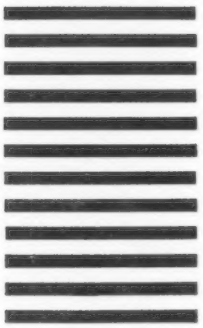

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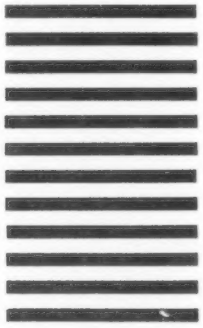

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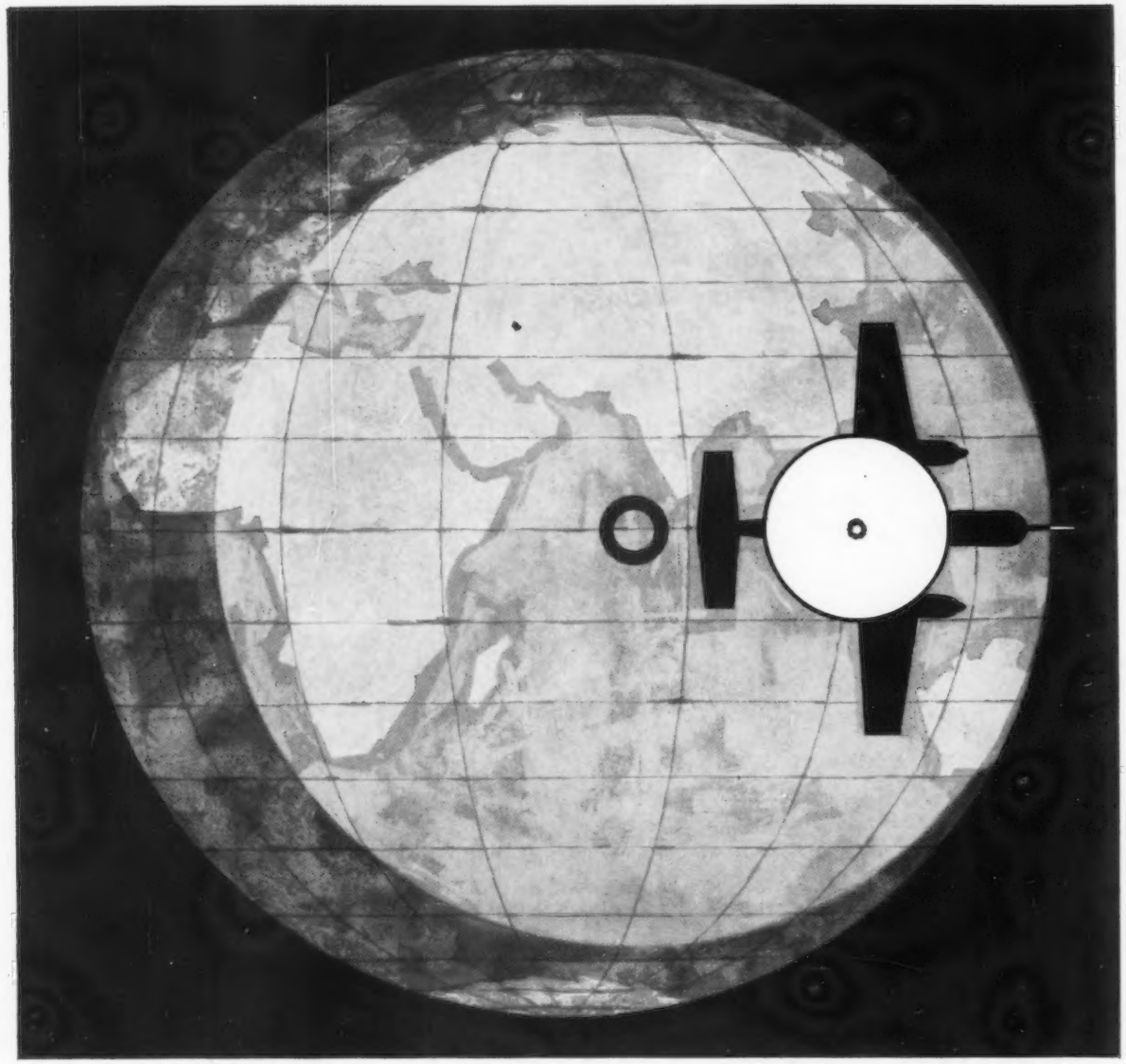

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